Newport Bay Watershed Urban Nutrient TMDL Compliance Evaluation

Final Report

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County of Orange - Public Facilities & Resources Department

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Executive Summary

An evaluation of nutrient loading in the San Diego Creek Watershed with respect to the Regional Board's nutrient TMDL targets for the years 2002, 2007, and 2012 is provided. Historical data from three representative monitoring stations in the watershed was used in conducting these evaluations. These stations included San Diego Creek at Culver, San Diego Creek at Campus, and Peters Canyon Channel at Barranca. The three stations were selected based on availability and completeness of historical data as well as urban cover increases in their tributary areas. Results indicate that the 1998-99 estimated urban runoff nutrient loads at the three selected monitoring stations meet the 2002 TMDL limits established for the Newport Bay Watershed/San Diego Creek (Reach 1), except for the dry season nitrogen load in Peters Canyon Channel at Barranca which is slightly (less than 3 percent) above the TMDL limit. The 1998-99 phosphorous loads were found to be below the phased TMDL limits.

In the year 2007, the current estimated urban runoff nutrient loads would be below the TMDL objectives except for dry season total nitrogen loads at San Diego Creek at Campus and Peters Canyon Channel at Barranca. By 2012, the current estimated nitrogen loads at San Diego Creek at Culver would be below the TMDL objectives. However, the dry and wet season computed loads in San Diego Creek at Campus and the dry season and annual loads in Peters Canyon Channel at Barranca would be above the 2012 limits.

Since the current estimated loads are all below or very near the 2002 TMDL objectives, it is assumed that the existing controls and BMPs are effective in controlling nutrient loads in the watershed. For this reason, the main BMPs recommended in this report include continuations of the successful programs in place in the watershed. However, the urban nutrient loads presented in this report were estimated due to the lack of specific urban runoff nutrient data in this watershed. Thus, it is recommended that future monitoring efforts be supplemented with specific source monitoring studies to better quantify nutrient loads from various sources including urban runoff. With the determination of urban runoff nutrient loads, a detail of specific BMPs targeted to achieve the phased TMDL limits and a plan/schedule for their implementation could be constructed. In addition, it is recommended that future efforts include pilot studies to test the effectiveness of special BMPs in reducing nutrient loads from urban sources. The specific need for BMPs, and a plan and schedule for their implementation shall be evaluated upon completion of these studies.

1. Introduction

In September 1999, a preliminary evaluation of urban runoff nutrient control effectiveness in the Newport Bay Watershed was presented in the report entitled, "*Newport Bay Watershed Urban Nutrient TMDL Technical Report"* (7). Numeric objectives were preliminarily assessed and an approach for compliance was presented. This report presented an overview of a range of Best Management Practices (BMPs), which may be effective in reducing nutrient loads in the Newport Bay Watershed and achieving the numerical goals. In a letter dated October 26, 1999, the Santa Ana Regional Water Quality Control Board (Regional Board) approved the proposed workplan presented in this report. The workplan recommended further examination of the TMDLs and an approach for evaluating urban nutrient loading and control effectiveness.

The report presented here is a summary of tasks performed, as presented in the September 1999 report and proposed workplan. This work includes a further evaluation of nutrient loading in the San Diego Creek Watershed. The following sections provide an evaluation of the TMDLs and numeric objectives, watershed conditions and land uses, historical loading trends at selected monitoring stations, current BMP programs, and a preliminary evaluation of effectiveness of the current BMP programs. Finally, recommendations for implementation of new and modified BMPs to meet the numeric objectives, as well as an implementation plan and schedule are provided.

2. TMDL Evaluation

In order to comply with the urban nutrient loading allocations in the San Diego Creek/Newport Bay Watershed, an understanding of the TMDL targets is necessary. The TMDL is defined as "the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loading (the loading capacity) is not exceeded. An assessment of current and previous nutrient loading (presented in Section 5), will aid in determining needs for compliance with respect to the target schedule.

2.1 Numeric Objectives and Target Schedule

The nutrient TMDLs established for San Diego Creek and Newport Bay are detailed in the U.S. EPA report dated April, 1998 (12) and subsequently in amendments to the Regional Board's Water Quality Control Plan (Basin Plan). The TMDLs for Newport Bay were established on the basis of trying to reduce nutrient loads to approximately the same level as was observed in the early 1970s and to levels below those observed prior to the widespread presence of aquatic macrophytes in the Bay (12). These TMDLs include specific annual/seasonal nutrient loading goals for urban runoff as well as other sources of runoff. The loading capacities are partitioned into two categories of waste load and load allocations. Waste load allocations include urban runoff and other NPDES discharges including nurseries, agricultural discharges, and undefined sources compromise load allocations.

The total nutrient TMDL loading capacity (sum of waste load allocation and load allocation) for Newport Bay is targeted at an annual rate of 298,225 pounds of total nitrogen and 62,080 pounds of total phosphorous by 2012. Of the total nitrogen loading capacity, 111,381 pounds comprise the waste load allocations, and 186,844 pounds the load allocations. Similarly, with the total phosphorous loading capacity, 15,770 pounds is permitted under waste loads and 46,310 pounds from load allocations. The urban runoff annual share of this allowable discharge is 72,070 pounds of total nitrogen (24 percent of the total loading capacity) and 2,960 pounds of phosphorous (about 5 percent of total loading capacity). The urban runoff total nitrogen share has been further divided into 55,442 pounds (about 77 percent of total urban runoff load) during the wet season (October 1 - March 31) and 16,628 pounds (about 23% of total urban runoff load) during the dry season (April 1 - September 30). The total nitrogen load limits in the wet months do not apply on days for which the mean daily flow exceeds 50 cubic feet per second as a result of precipitation (San Diego Creek at Campus).

A separate TMDL for San Diego Creek, Reach 1 (Jeffrey Road to Newport Bay) has not been established, since the total nitrogen TMDL applicable to the Newport Bay Watershed should result in attainment of the objectives in this reach (total annual nitrogen TMDL of 265,482 pounds) by 2012 (12). The wet and dry season total loading capacities are 128,286 pounds and 137,196 pounds, respectively. About 22 percent (59,097 pounds) of the total load is allocated to urban runoff discharges, of which 77 percent (45,462 pounds) is permitted in the wet season and 23 percent (59,097 pounds) in the dry season.

San Diego Creek, Reach 2 (Jeffrey Road to headwaters) total nitrogen TMDL objective is set for 14 pounds per day, of which 5.5 pounds per day is allowed for waste loads (2012 target). These loads do not apply on days for which the mean daily flow rate in San Diego Creek at Culver Drive exceeds 25 cubic feet per second as a result of precipitation. The TMDL for Reach 2 is as stated in the Regional Board Basin Plan.

The State Water Resources Control Board (the State) and the Regional Board have adopted 5-year, 10-year, and 15-year load allocations to the Newport Bay. The Regional Board adopted these TMDLs on April 17, 1998, in the form of a Basin Plan amendment presented as *"Attachment to Resolution No. 98-9."* On May 13, 1998, the State approved the Basin Plan amendment, which was then forwarded to the Office of Administrative Law (OAL) for review. Following this review, OAL recommended areas of the Basin Plan amendment that needed further clarification. To address this, on October 9, 1998, the Regional Board adopted Resolution No. 98-100, amending Resolution No. 98-9.

The Regional Board TMDL implementation plan establishes targets for reducing the total annual loading of nitrogen and phosphorous to Newport Bay by 50% (from a base of annual average loading from years 1990-97) to meet the numeric and narrative water quality objectives by year 2012. To achieve these targets, the TMDL criteria establish interim targets of 30% and 50% nutrient (nitrogen and phosphorous) reduction in summer flows by 2002 and 2007, respectively, and a 50% reduction in non-storm winter loads by 2012. Table 1 presents a summary of the Regional Board load allocations for the Newport Bay Watershed.

Table 1
Seasonal and Annual Nutrient Load Allocations for the Newport Bay Watershed*
(Source: Regional Board Resolution No. 98-100)

TMDL	Target Date	Wet Season Load (lbs.)	Dry Season Load (lbs.)	Total Annual Load (lbs.)
Total Nitrogen from All Sources	December 31, 2002	-	200,097	-
Total Nitrogen from Urban Runoff (%)**	December 31, 2002	-	20,785 (10%)	-
Total Nitrogen from All Sources	December 31, 2007	-	153,861	-
Total Nitrogen from Urban Runoff (%)**	December 31, 2007	-	16,628 (11%)	-
Total Nitrogen from All Sources	December 31, 2012	144,364	153861	298,255
Total Nitrogen from Urban Runoff (%)**	December 31, 2012	55,442 (38%)	16,628 (11%)	72,070*** (24%)
Total Phosphorous from All Sources	December 31, 2002	-	-	86,912
Total Phosphorous from Urban Runoff	December 31, 2002	-	_	4,102 (5%)
Total Phosphorous	December 31, 2007	-	-	62,080
Total Phosphorous from Urban Runoff (%)**	December 31, 2007	-	-	2,960 (5%)

* The annual/seasonal targets were developed from a base annual load of 1,078,000 pounds (1990-97).
** Percent of total nutrient from all sources.
*** Source: reference (12).

The Nitrogen TMDLs presented in Table 1 are applicable to Newport Bay Watershed including San Diego Creek, Reach 1. San Diego Creek, Reach 2 has a total nitrogen daily load allocation of 14lbs/day targeted for December 31, 2012. The flow rates in San Diego Creek Reach 1 have increased since the 1970's because of development in its tributary areas. The concentrations of total nitrogen, however, have remained high because of yet undetermined factors. Even with a 50% reduction in the current total nitrogen loading, it is likely that average concentration in Reach 2 would remain close to or above 5 mg/L (12). By December 31, 2000, the Regional Water Quality Control Board will review and revise (if necessary) the nitrogen loading TMDL for Reaches 1 and 2 of the San Diego Creek. The Board will also investigate the need for establishing numeric phosphorous objectives for San Diego Creek, Reaches 1 and 2.

2.2 Background

Several studies have been conducted in the recent years to identify sources of nutrients in the Newport Bay Watershed. Even though the nutrient sources have been mostly identified, the magnitude of individual nutrient contributions is not well known (12). In 1998, Tetra Tech provided an analysis of annual total nitrogen loading from various dischargers and land use categories within the San Diego Creek Watershed (11). The average and maximum nitrogen loading for total urban sources in the San Diego Creek Watershed was estimated to be 256,979 pounds and 427,090 pounds, respectively. This analysis was performed using unit-loading rates obtained from literature. The Regional Board used this analysis as a baseline for determining allocations for urban and agricultural sources. The following is a summary of key relevant elements of this study:

a. The QUAL2E model was used to simulate nitrogen and eutrophication in San Diego Creek and Newport Bay Watershed.
b. Average field data from 1985-97 was used for model calibration. This period was chosen since it represents the most critical time period for observing elevated nitrogen levels.
c. Sources of nutrients to the system included three nurseries: Bordiers, El Modeno Gardens, and Hines, as well as non-point sources from urban runoff, agricultural discharges, and other undefined runoff.
d. Flow, nitrate and ammonia data for the three large commercial nurseries in the Upper Newport Bay Watershed was provided for the period from April-September 1997. The remaining parameters were estimated.
e. Summer period was defined as April-September.
f. The study stream segments included: San Diego Creek from just upstream of its entrance to Newport Bay to the confluence with Serrano Creek; Peters Canyon Channel to the El Modeno Gardens nursery; Marshburn Channel to Bordiers Nursery; and Rattlesnake Canyon Wash/Hicks Canyon Wash to Hines Nursery.
g. The annual and seasonal nitrogen loads for three periods (1990-97, 2002, and 2007) were compiled for the entire watershed and then distributed among subwatersheds by applying unit loading rates.
h. The following relationships were used in the simulation model:

Total Nitrogen (TN) = given.
Nitrite Nitrogen (NO2-N) = assumed to be 0.10 mg/L.
Nitrate Nitrogen (NO3-N) = 0.916*TN - NO2-N.
Total Kjeldahl Nitrogen (TKN) = TN - (NO2-N) – (NO3-N).
Total Phosphorous (TP) = 0.106*NO3-N.

i. Analysis included three separate simulations:

1) 1997 permitted nutrient loads from the nurseries and the estimated 1990-97 nonpoint sources including urban, agriculture, and other undefined sources. Under this scenario the objectives of 5 mg/L of total nitrogen (TN) upstream of Jeffrey Road and 13 mg/L of TN downstream of Jeffery Road were not achieved.

2) Year 2002 allocations.
Under this scenario, objectives downstream of Jeffery Road (TN=13 mg/L) could be met in San Diego Creek but not in Peters Canyon Channel. The 5 mg/L TN objective was not achieved in San Diego Creek upstream of Jeffery Road.

3) Year 2007 allocations.
Under this scenario, the 13 mg/L objective was met in both San Diego Creek and Peters Canyon Channel. The 5 mg/L TN objective was not achieved in San Diego Creek upstream of Jeffery Road.

j. The following is a summary of total load allocations for TN in San Diego Creek watershed as reported in the 1998 Tetra Tech analysis (11):

- 1990-97 total loading: 1,027,275 pounds per year.
- 1990-97 urban runoff loading: 227,247 pounds per year.
- 1990-97 total loading per wet season: 295,459 pounds (1,619 pounds per day).
- 2002 total loading allocation: 195,667 pounds per wet season (1,072 pounds per day). This is about 34% reduction from 1990-97.
- 2002 urban runoff loading allocation: 17,044 pounds per wet season (93 pounds per day). This is about a 25% reduction from 1990-97
- 2007 total loading allocation: 153,861 pounds per wet season (843 pounds per day). This is about 48% reduction from 1990-97.
- 2007 urban runoff loading allocation: 16,628 pounds per wet season (91 pounds per day). This is about 27% reduction from 1990-97.

3. Selection of Representative Monitoring Stations

A general overview of the Newport Bay nutrient TMDLs was presented in Section 2. As mentioned before, the TMDLs were primarily established on the basis of reducing nutrient loads to about the same level as the early 1970's. One of the main objectives of the study presented here is to evaluate and compare current and historical nutrient loading in the watershed with the TMDL targets. Nutrient loading calculations were performed at representative stations in the watershed. This section provides the basis for selection of these representative monitoring stations.

From 1991 to 1998, the Orange County Stormwater Monitoring Program operated and maintained thirteen channel monitoring stations in the Newport Bay Watershed (Figure 1). Channel monitoring in a few stations started in the 1970s. Channel monitoring is conducted by grab sampling or by using automated samplers, typically on a monthly basis. For dry weather discharge monitoring, the stations are programmed to collect a discrete sample once an hour for a 24-hour period. During storms, sampling is initiated when the water level in the channel reaches above a triggering device hardwired to the automated sampler. The nutrient compounds that are monitored during the dry and wet seasons include ammonia, nitrate, total kjeldahl nitrogen, phosphate, and orthophosphate (special investigations only).

Three representative automated monitoring stations were selected for further data analysis and assessments. One of the objectives of this study was to assess historical stormwater nutrient quality changes with increased urban cover of the tributary areas. Thus, the criterion for selection of representative monitoring stations was based on historical urban cover increases, as well as availability and completeness of historical non-stormwater nutrient data. Only three stations met this criterion and were thus selected for further analysis. These included Peters Canyon Channel at Barranca (Station 8), San Diego Creek at Campus (Station 10), and San Diego Creek at Culver (Station 11).

Figure 1. Upper Newport Bay Watershed Automatic Samplers Location

1 Agua Chinon Wash at Irvine Center Drive and Pacifica
2 Barranca Channel at Main Street
3 Bee Canyon Channel at Alton and Pacifica
4 Bonita Canyon Channel at San Diego Creek Confluence
5 Costa Mesa Channel at Westcliff Drive
6 Hicks Canyon Wash at Culver Drive
7 Lane Channel at McCabe Way
8 Peters Canyon Channel at Barranca Parkway
9 Rattlesnake Canyon Wash at Bryan Avenue
10 San Diego Creek at Campus Drive
11 San Diego Creek at Culver Drive
12 Sand Canyon Channel at Culver and University

13 Santa Ana Delhi Channel Upstream Irvine Avenue

3.1 Watershed Land Use Assessment

As discussed in the previous TMDL Technical report (7), urban development has been identified as one of the principal sources of nutrients in the Upper Newport Bay/San Diego Creek Watershed. A preliminary investigation of current land uses in the Newport Bay Watershed was undertaken to better understand the urban sources of runoff into the San Diego Creek/Newport Bay. It was found that the Newport Bay Watershed includes an area of almost 150 square miles. The San Diego Creek Watershed, which includes Peters Canyon Channel, is about 111 square miles with a mix of residential, commercial, industrial, recreational, and open space land uses. The remaining 39 square miles tributary to the Newport Bay include the Santa Ana Delhi Channel, Bonita Creek, Big Canyon Wash, and a number of smaller tributaries comprised of mostly developed areas. The Newport Bay Watershed includes portions of the Cities of Newport Beach, Irvine, Laguna Hills, Lake Forest, Laguna Woods, Tustin, Orange, Santa Ana, and Costa Mesa as well as unincorporated County areas.

This section presents an evaluation of the tributary area land uses for the thirteen channel monitoring stations in the Newport Bay Watershed (Table 2). The analysis compares the most recent and updated land use information readily available to the late 1970's-early 1980's land uses. The late 1970's-early1980's watershed tributary areas and land use information was obtained from a 1982 study prepared by Boyle Engineers entitled "*Sediment Source and Delivery Analysis*". Updated land use coverage of the Newport Bay Watershed was obtained from Orange County (January 1999).

The 1982 Boyle Study provides a hydrologic delineation of the subwatersheds within the Newport Bay/San Diego Creek Watershed. This information was used in estimating tributary areas as well as percent land uses tributary to the thirteen channel monitoring stations. The land use covers were overlain on the subwatershed delineations presented in the 1982 Boyle Study. The area of each subwatershed associated with four main land use categories (agriculture, open space, urban, and construction) was estimated using GIS procedures. The 1982 study's tributary areas were updated with recent land use information obtained from a vegetation map in evaluation of the current land uses which reflect estimates of the conditions of the watershed as of January 1999.

The four main land use categories presented in this analysis include agriculture, open space, urban, and construction. Urban cover includes residential, commercial, industrial, public & semi public, transportation, communication & utility, and roads. Table 3 presents a breakdown of land uses in the sub-watersheds upstream of the thirteen water quality sampling stations in the Newport Bay Watershed. Percent increase in urban cover is included in Table 3.

One of the goals of this investigation was to examine the impacts from increased urban uses on stormwater quality conditions. The primary objective of the analysis presented in this section is to identify monitoring stations which have experienced the highest urbanized growth over the period of the stormwater quality record. As indicated previously, this analysis, coupled with historical nutrient data availability aids in ranking and selection of representative monitoring stations for further evaluation.

Comparison of the historical trends and stormwater quality loads at the two time periods examined (early 1980's to 1999) may help in understanding the impacts caused by urbanization of the watershed.

Based on this analysis, the top four monitoring stations with the highest increase in urban cover are ranked as follows (Table 3):

1) Agua Chinon Wash at Irvine Center Drive and Pacifica (Station 1).
2) Sand Canyon Channel at Culver and University (Station 12).
3) Costa Mesa Channel at Westcliff Drive (Station 5).
4) A tie between Bee Canyon Channel at Alton and Pacifica (Station 3), Bonita Canyon Channel at San Diego Creek Confluence (Station 4), and San Diego Creek at Campus (Station 10).

Table 2
Monitoring Station General Information
Upper Newport Bay Watershed Automated Sampler Location

Station Number	**Station Name**	**Channel**	**Tributary Area (mi2)**	**City**
1	Agua Chinon Wash at Irvine Center Drive and Pacifica	F18	7.2	Irvine, Lake Forest
2	Barranca channel at Main Street	F09	2.7	Irvine, Santa Monica, Tustin
3	Bee Canyon channel at Alton and Pacifica	F17	11.2	Irvine
4	Bonita Canyon Channel at San Diego Creek Confluence	F04	5	Irvine, Newport Beach
5	Costa Mesa Channel at Westcliff Drive	G02	1	Costa Mesa, Newport Beach
6	Hicks Canyon Wash at Culver Drive	F27	7.5	Irvine
7	Lane Channel at McCabe Way	F08	4.6	Irvine, Santa Ana
8	Peters Canyon Channel at Barranca Parkway	F06	45.2	Irvine, Santa Ana
9	Rattlesnake canyon Wash at Bryan Avenue	F26	3.5	Irvine, Tustin
10	San Diego Creek at Campus Drive	F05	111	Irvine, Lake Forest, Orange, Santa Ana, Tustin
11	San Diego Creek at Culver Drive	F05	41.8	Irvine, Lake Forest

12	Sand Canyon Channel at Culver and University	F15	9.6	Irvine
13	Santa Ana Delhi Channel upstream Irvine Avenue	F01	17.6	Costa Mesa, Irvine, Newport Beach, Santa Ana

Table 3
Changes in Urban Cover in the Subwatersheds Upstream of Channel Monitoring Stations

Ranked Station Number	Area (mi2)	Percent Land use Cover Early 1980s Conditions				Percent Land Use Cover Current Conditions				% Increase in Urban Cover
		Ag	Open Space	Urban	Construction	Ag	Open Space	Urban	Construction	
1	7.2	43	52	5	0	15	50	29	7	24
12	9.6	0	85	11	4	2	69	28	0	17
5	1	0	18	80	3	0	6	93	1	13
3	11.2			17				28		11
4	5	0	80	16	4	0	51	27	22	11
10	111	29	30	39	2	18	29	50	4	11
8	45.2	39	15	46	0	25	17	55	3	9
11	41.8	28	44	27	1	18	43	34	5	7
2	2.7	27	0	73	0	7	11	78	4	5
13	17.6	3	0	97 (93)*	0	1	2	96	1	3
7	4.6	10	0	90	0	0	7	90	3	0

6	7.5	-	-	-	-	Mostly open space and agriculture	-
9	3.5	-	-	-	-	Mostly agriculture	-

* Per data presented on Table 5.4, "Land Uses Upstream of Automatic Sampling Stations: 1990 Data" provided by PFRD.

3.2 Historical Nutrient and Flow Data

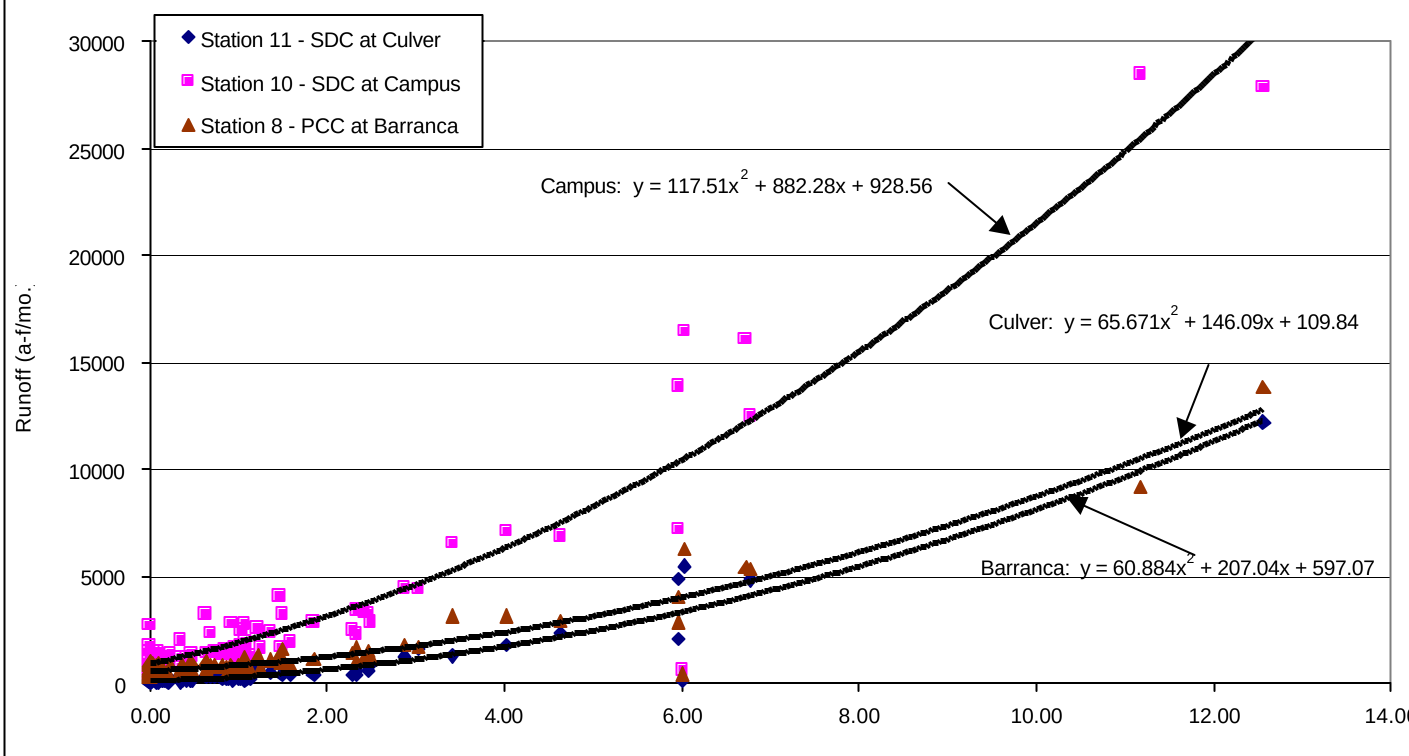
Water quality data availability and data continuity played a determining role in selection of the monitoring stations for further data analysis. As mentioned before, many of the Orange County stormwater monitoring stations do not have adequate and complete nutrient and flow records to compute and assess the historical nutrient loads in the watershed. More comprehensive monitoring efforts have been recently initiated and more focused investigations are underway which ensures a better characterization of nutrient loads in the future. Specifically, Orange County has made an effort since 1990 to put special focus on nutrient characterization in the Newport Bay Watershed. In addition, a fairly aggressive nutrient monitoring program has been recently (1999) initiated to characterize nutrient loads from a mostly urban cover watershed at the Costa Mesa Channel at Westcliff Drive (Station 5) and from Peters Canyon Channel at Barranca Parkway (Station 8).

According to the Orange County Public Facilities & Resources Department (PFRD), the only channel monitoring station in the San Diego Creek Watershed that has nutrient data back to early 1970's is the San Diego Creek at Campus (Station 10). Other stations such as Peters Canyon Channel at Barranca Parkway (Station 8) and San Diego Creek at Culver (Station 11) have some nutrient data starting in the mid-1980's. Since nitrate control has been the main focus of previous nutrient control measures, less phosphorous data is available throughout the watershed. Table 4 provides a summary of available nutrient record at the three selected monitoring stations.

Daily channel flow data needed to compute the runoff volume and consequently the nutrient loads, were obtained from the County flow gage records. Even though flow records at the three monitoring stations are fairly complete, a few gaps were observed for the periods examined (Table 4). Thus, rainfall-runoff regression models were developed by correlating actual rainfall data from the Tustin-Irvine Ranch precipitation station (Station No. 61) to actual flow data at the three selected monitoring stations (see Section 3.3) to predict flows for periods of no record.

Prior to performing the nitrogen loading calculations, the regression models were used to predict flow rate for the periods of no record. The wet season flow records were scanned for and excluded data from days in the wet season on which the mean daily flow rate in San Diego Creek at Campus Drive (Station 10) exceeded 50 cubic feet per second (as a result of precipitation) per the TMDL guidelines. Nitrogen data from the days exceeding the flow rate criteria was omitted from the analysis provided here. Finally, flow rates were converted into flow volumes prior to performing the load computations. Figure 2 shows the rainfall-runoff regression models.

Figure 2
Rainfall Runoff Regression Models*



* rainfall measured at Tustin-Irvine Ranch Station

3.3 Representative Stations Selected for Further Evaluation

Three channel monitoring stations were selected for further analysis and evaluation for compliance with the TMDL objectives (Table 4). These stations were selected based on completeness of their flow and nutrient data as well as increases in tributary area urban cover. All three stations exhibited urban cover increases from late-1970's to present. These stations include San Diego Creek at Campus (Station 10), Peters Canyon Channel at Barranca (Station 8), and San Diego Creek at Culver (Station 11).

Table 4
Available Record at the Three Selected Monitoring Stations

Station (Number)	**Nutrient Data**	**Flow Data**	**Flow & Nutrient Data**	**Rainfall Data** (Tustin -Irvine Ranch)
San Diego Creek @ Campus (10)	11/23/66 to 6/24/99	10/1/77 to 9/30/79 10/1/82 to 6/30/99	10/1/77 to 9/30/79 10/1/82 to 6/30/99	7/1/1897 to 6/30/1999
Peter Canyon Channel @ Barranca (8)	2/13/86 to 6/17/99	10/1/82 to 6/30/89 7/1/91 to 6/30/99	2/13/86 to 6/30/89 7/1/91 to 6/30/99	7/1/1897 to 6/30/1999
San Diego Creek @ Culver (11)	2/13/86 to 6/17/99	10/1/49 to 6/30/89 7/1/91 to 6/30/94 7/1/95 to 6/30/99	2/13/86 to 6/30/89 7/1/91 to 6/30/94 7/1/95 to 6/30/99	7/1/1897 to 6/30/1999

4. Existing BMPs

A preliminary evaluation of nitrate concentrations at the San Diego Creek at Campus Drive (Station 10) by Blodgett (1) showed a downward trend after peaking in 1985. This section provides a brief investigation of the current BMPs implemented in the watersheds upstream of the three selected monitoring stations. This information, correlated with historical nutrient loading trends presented in Section 5, may help evaluate effectiveness of the current urban nutrient controls. An analysis of effectiveness of the current BMPs was essential before recommendations for future and new BMP programs could be made.

The 1998 PFRD Annual NPDES Progress Report illustrates the BMP programs implemented by each permittee in the 1997-98 period (8). The Orange County Drainage Area Management Plan (DAMP) describes program requirements and existing stormwater discharge control measures in each city in Orange County (6). Finally, the Orange County Newport Bay Urban Nutrient TMDL Technical Report (7) provided an evaluation of each control program and whether program revisions are believed to be necessary.

Table 2 shows a summary of all past and present monitoring stations within the Upper Newport Bay Watershed including city jurisdictions within the watersheds. Table 5 includes an updated summary of the stormwater discharge control measures in the cities located in the watersheds upstream of the selected monitoring stations, as presented in the DAMP (6). All permittees within the watershed have adopted the DAMP and implemented its programs to eliminate non-stormwater discharges and to improve water quality conditions.

An assessment of the current programs indicates that all municipal permittees routinely conduct preventive maintenance activities, which the watershed permittees believe have been effective in controlling nutrients in stormwater (7). The implemented BMPs currently include: water quality ordinances, litter control, solid waste collection/recycling, drainage facility maintenance, catch basin stenciling, street sweeping, hazardous materials management/environmental performance reporting, household hazardous waste collection, emergency spill response, fertilizer and pesticide management, public education, requirements for Water Quality Management Plans (WQMPs) for new and significant re-development projects, non-structural and structural BMPs for public works construction projects, illicit connection/discharge identification and elimination, and water quality monitoring efforts. The WQMPs address non-structural BMPs (such as litter control and landscape management) and structural BMPs (such as water quality inlets, energy dissapators, and runoff diversion) that will need to be implemented as a part of development projects.

A review of the 1997-98 NPDES Annual Progress Report (8) indicates that the majority of the cities located in the tributary areas upstream of the three monitoring stations have been very active with the BMP implementation program. The progress report provides information on each city's activities as well as costs spent on the control activities (capital and operations & maintenance). The watershed permittees believe that the majority of these programs are effective in nutrient control without a need for substantial revision to the existing programs and or the DAMP (7).

The Newport Bay Urban Nutrient Technical Report (7) suggests a need for more focused public education programs and material addressing nutrient control which will be addressed in subsequent annual NPDES reports. Also, the watershed permittees intend to evaluate additional BMPs targeting nutrient controls that may be applicable for new developments. Finally, it has been agreed that a need for additional regional nutrient monitoring as part of theTMDL process exisits and a Regional Monitoring Program (RMP) has been developed to address this need.

In addition to the routine BMPs, many public agencies located within the Newport Bay Watershed (such as Irvine Ranch Water District and the Cities of Irvine, Costa Mesa, and Newport Beach) have sponsored the Orange County Landscape Performance Certification Program with the main objective of increasing landscape irrigation efficiencies in their jurisdictions. This program is designed to educate, train, certify, and promote efficient landscape irrigation techniques. As an example, Irvine Ranch Water District (IRWD) has recently proposed new and innovative water conservation approaches to reduce water usage and thereby reduce runoff which will have a positive impact on reducing runoff nutrient loads from urban landscape surfaces. The water conservation approach includes proper irrigation designs based on better definition of consumptive uses. This leads to better control and/or elimination of irrigation runoff from urban landscape surfaces.

The regional structural controls in the Newport Bay/San Diego Creek Watershed include a number of floodplain management controls as well as sediment and water quality controls. There are currently numerous flood and sediment control basins within the watershed. In addition to the primary objective of flood and sedimentation control, these basins will have a positive impact in the reduction of nutrient loads in the watershed. The reduced nutrient loads in the recent years (discussed in Section 5) may be partially attributed to the successful implementation of these controls.

Finally, the County of Orange, funded by a grant from EPA (via the California Coastal Conservancy) is currently assessing the potential for enhancing water quality, sediment control, fish and wildlife habitat and recreational opportunities in the Lower San Diego Creek Watershed. This assessment includes preliminary recommendations of measures to reduce nutrient loading in the watershed. These recommendations include:

- Consistent monitoring of water quality parameters
- Inspections and enforcement of construction site compliance with required BMP
- Establishment of a program to reduce fertilizer use by private landowners (including homeowners' associations) particularly residential and nurseries
- Revegetation of riparian buffers to provide some filtering of nutrients and other pollutants during storm events and other higher flow periods
- Creation of a moderate to high flow connection between lower San Diego Creek and the San Joaquin Marsh Reserve.

These recommendations will be considered as part of broader watershed restoration studies being conducted with the U.S. Army Corps of Engineers.

Table 5
Existing Stormwater Discharge Control Measures for
Cities Upstream of the Selected Monitoring Stations

BMP*	**Irvine (upstream of Stations 8, 10 , & 11)**	**Santa Ana (upstream of Stations 8 & 10)**	**Lake Forest (upstream of Stations 10 & 11)**	**Orange (upstream of Station 10)**	**Tustin (upstream of Station 10)**	**County Un-incorporated (upstream of Stations 8, 10, & 11)**
Litter Control						
Recycling						
Drainage Facility Maintenance						
Catch Basin Stenciling						
Street Sweeping						
Hazardous Materials Management						
Household Hazardous Waste Collection						
Emergency Spill Response						
Fertilizer Management						
Pesticide Management						
Public Education						
New Development WQMPs						

Construction Controls						
Illicit Connection/Discharge Identification and Elimination						

	Program Implemented

*A detailed description of each BMP is provided in the Orange County Drainage Area Management Plan (6).

5. Data Analysis

This section provides a summary of historical nutrient loading calculations for the three selected monitoring stations in the Newport Bay/San Diego Creek Watershed. Results from other previous and recent studies are also included for comparative purposes. An overview of calculation procedures, data results, comparison with TMDL objectives, evaluation of historical loads, and spatial distribution of the loads is provided.

5.1 Previous and Recent Nutrient Loading Investigations

Previous nutrient assessments in the Newport Bay Watershed indicate that the majority of the total phosphorous load in the San Diego Creek Watershed comes from Peters Canyon Channel (62%) and San Diego Creek above Culver Drive (27%) (12). The Regional Board estimated that about 124,160 pounds of total phosphorous load is delivered annually to the Bay. It was also determined that San Diego Creek contributes the vast majority (80%) of the total phosphorous load to Newport Bay. In 1997, the Regional Board found that the three large commercial nurseries and other agricultural sources comprise the major sources of nutrients in the Newport Bay Watershed (12).

According to the EPA (12), the total nitrogen TMDL for Newport Bay low-flow nitrate loadings are lower than the early 1970s. Nitrogen compounds found in Newport Bay include nitrate, ammonia, and organic nitrogen. The inorganic forms of nitrogen, nitrate, nitrite, and especially ammonia, are readily available for marine plants and cause the algae blooms. The majority of nitrogen is in the form of nitrates, and data indicates that the greatest contributions occur during low flow conditions. Nitrate concentrations in the bay are dependent on freshwater input, tidal conditions, depth, and biological processes. Historical data shows that the majority of the nitrogen measured (about 90%) in the San Diego Creek is in the form of inorganic nitrogen. EPA (12) evaluated the total inorganic nitrogen concentrations at the two San Diego Creek Monitoring Stations (Stations 10 and 11). Data was statistically evaluated for the wet and dry seasons. Table 6 provides a summary of this analysis.

Table 6
Total Inorganic Nitrogen Concentrations - 1990 to 1997
San Diego Creek Monitoring Stations (6)

	San Diego Creek @ Campus (Station 10)		**San Diego Creek @ Culver (Station 11)**	
	(wet season) October-March	**(dry season) April-September**	**(wet season) October-March**	**(dry season) April-September**
Average	14.1 mg/L	14.8 mg/L	9.5 mg/L	15.4 mg/L
Standard Deviation	6.1	3.8	7.9	6.5

According to Blodgett (1), the annual nitrate loading to the bay from the San Diego Creek Watershed reached a peak of 7 million pounds (1.6 million pounds as nitrate-nitrogen) during 1985-86. Data from 1973-74 suggested a total nitrogen load of 428,000 pounds (about 383,000 pounds of total nitrate) from San Diego Creek during low flow conditions (12). Nitrogen loading data from 1976 to 1988 indicate a significant downward trend entering the bay from San Diego Creek since the peak in 1985-86 (associated with peak algae blooms). This reduction may have been attributed to construction of in-bay sediment basins, and/or reduced loads from the San Diego Creek Watershed. The Total Inorganic Nitrogen (TIN) concentrations have steadily decreased since 1976 at the Upper Bay. At the same time, mean phosphate concentrations for the period between 1976 and 1988 were higher for San Diego Creek than the Santa Ana Delhi Channel. This could be attributed to higher sediment loads from the less-urbanized portions of the San Diego Creek Watershed.

In order to determine the nutrient TMDLs in the Newport Bay/San Diego Creek Watershed, Tetra Tech provided an estimation of average and maximum nitrogen loading at the three selected monitoring station locations (12). The San Diego Creek at Campus watershed was considered to include all areas tributary to San Diego Creek at Campus minus areas tributary to San Diego Creek at Culver and Peters Canyon at Barranca. Table 7 is a brief summary of these estimations.

Table 7
Average and (Maximum)
Nitrogen Loading Estimation in pounds (12)

Source	Peters Canyon at Barranca (Station 8)	San Diego Creek @ Culver (Station 11)	San Diego Creek @ Campus (Station 10)	Total Loads
Urban	104,017 (164,408)	93,506 (161,755)	59,456 (100,929)	256,979 (427,090)
Total	475,709 (450,990)	352,391 (345,728)	91,057 (122,534)	919,156 (919,253)
Total (1990-97 Average)*	557,265	217,122	145,107	919,494

*Regional Board Loading Estimation

Orange County conducted a nitrate study in May, 1993 to determine nitrate loading in San Diego Creek and Santa Ana Delhi Channel (2). Results were compared to previous studies conducted in 1990 and 1991. The total nitrate-nitrogen loading rates in the San Diego Creek at Campus Drive during 1990, 1991 and 1993 were estimated to be 1,150, 894 and 1,570 pounds per day, respectively.

During September 13-20, 1999 PFRD conducted a focused nutrient study in the Peters Canyon Channel/San Diego Creek watersheds (3). In addition to the main stations, data was collected at other tributaries to determine contributions from the main subwatersheds. The following is a brief summary of this study's findings:

a. Average nitrate (as N) load at the Peters Canyon Channel at Barranca was measured to be 318.8 pounds per day (at an average water discharge rate of 5.61 cfs).
b. The highest nitrate (as N) load contributors in Peters Canyon Channel were: Valencia Storm Channel (88.2 pounds per day), Santa Ana-Santa Fe Channel (78.1 pounds per day), Central Irvine Channel (67.4 pounds per day), Como Storm Channel (63.4 pounds per day), and the Warner Channel (49.5 pounds per day).
c. The average measured nitrate (as N) load in San Diego Creek at Harvard (a relocation of the San Diego Creek at Culver Station) was 126.3 pounds per day (at an average water discharge rate of 1.15 cfs). There were large disparities between nitrate loads and discharge rates from data measured at this station and collective data measured at upstream tributaries.
d. The average daily nitrate (as N) load measured in San Diego Creek at Campus was 381.5 pounds per day (at an average water discharge rate of 7.81 cfs).
e. During this study, Irvine Ranch Water District (IRWD) was pumping from and returning some of the San Diego Creek water to monitor the effectiveness of it’s wetland treatment system and to supply water to the San Joaquin Marsh, Irvine Company mitigation site and the Carlson Marsh. The mean nitrate (as N) load

pumped and returned to the creek were 201.2 and 15.3 pounds per day, respectively (net nitrate removal of 186 pounds per day).

f. The average daily total nitrogen loads measured from San Diego Creek at Campus, San Diego Creek at Harvard, and Peters Canyon Channel at Barranca were 435, 131, and 353 pounds per day, respectively.
g. The average daily phosphorous (as P) loads were measured to be 5.24 pounds per day in Peters Canyon Channel at Barranca and 5.03 pounds per day in San Diego Creek at Campus.
h. The extrapolated total nitrogen load for the period April 1 to September 30 at San Diego Creek at Campus was estimated to be about 80,000 pounds. Without the IRWD diversion, the total load was estimated be about 121,000 pounds.

5.2 Computation Methodology

Nutrient and flow data were obtained from PFRD in digital and hard copy format for the three selected monitoring stations under investigation (see Table 4). The water quality data was transformed into loads of nutrients using procedures outlined in this section. Statistical models were created which may be used to evaluate data and predict conditions at similar locations and/or in the future. In addition, graphs representing historical distribution of the nutrient loads were created to illustrate nutrient behavior over time.

The following is the step-by-step procedure used in estimating the annual and seasonal nutrient loads for the three selected monitoring stations:

a. Obtained nutrient concentrations from monthly channel monitoring data. These included: nitrate as NO3, ammonia (NH3), total kjeldahl nitrogen (TKN), total phosphate as PO4, and ortho-phosphate (O-PO4).

b. Individual nutrient concentrations were converted into Event Mean Concentrations (EMCs) for individual storm events and for years with incremental flow sampling (1994-95 to 1998-99 for Station 11, 1997-98 to 1998-99 for Station 10 and 1994-95 to 1998-1999 for Station 8). For years without incremental flow sampling, all measured concentrations were tabulated and used in analysis. Individual dry weather nutrient concentrations were tabulated for all years. All concentrations were presented in milligrams per liter (mg/L). The water years in this analysis are from October (beginning of wet season) through September (end of dry season).

c. Obtained rainfall depth for the period of nutrient record from the Tustin-Irvine Ranch precipitation station (e.g., monthly and annual).

d. Obtained daily flow measurements at the three monitoring stations and for the period of nutrient record.

e. Since a complete flow record was not available for all monitoring stations, rainfall-runoff regression models were developed by correlating actual rainfall data from the Tustin-Irvine Ranch precipitation station to actual flow data at the three selected monitoring stations (Figure 2). The regression models were used to predict flow rates for the periods of no record.

f. The daily flow record for the wet season (October 1 - March 31) were scanned for and precluded data from days on which the mean daily flow rate in San Diego Creek at Campus Drive (Station 10) exceeded 50 cubic feet per second (cfs) (as a result of precipitation) per the TMDL criteria. Nutrient data from days exceeding the flow rate criteria were omitted from the analysis provided here.

g. Daily flow rates were converted to average monthly flow rates.

h. Average monthly flow rates in cfs were converted into flow volumes in acre-feet for individual months in the wet (October 1 to March 31) and dry (April 1 to September 30) seasons as well as the total year for the entire period of record.

i. Runoff volumes from step h were converted from acre-in to liters using the conversion factor: 1 acre-feet = 1,233,480 liters. Total volume of runoff was computed for the wet and dry seasons as well as the entire year for the period of record.

j. Natural log of nutrient data (from Step b), were calculated.

k. Mean *(m)* and variance *(s^2)* of natural logs obtained from Step j were computed from the following equations:

$$m = \sum x / n$$

$$S^2 = ln\,(1 + CV^2)$$

$$CV = SD / m$$

$$SD = \sqrt{\frac{\left(n\sum EMC^2 - \left(\sum EMC\right)^2\right)}{\left(n(n-1)\right)}}$$

Where: x is the natural log of nutrient data from Step b.
EMC represents the event mean concentrations (or nutrient data from Step b).
n is the number of data points (x).
CV is the coefficient of variation.
SD is the standard deviation.
m is the mean of nutrient data from Step b.

l. Expected value a (also known as mean of the concentrations) was computed using the following formula:

$$a = e^{\left(\mu + \frac{s^2}{2}\right)}$$

m. Upper and lower confidence limits x_{hi} and x_{lo} were computed from m, s, and standardized normal deviate, z, were computed using the equation:

$$x = e^{(m +/- zs)}$$

The value of z corresponds to a given probability of exceedence, which can be converted to a confidence level. For a confidence level of 90%, the z value corresponding to 0.90 is 1.28 (obtained from a standard normal distribution table).

n. To obtain expected nutrient load, in the period of interest (season or year), the expected value (mean of the concentrations) from Step l was multiplied by the runoff volume obtained from Step i. Expected nutrient loads were converted to pounds (lbs) using the conversion factor of 1 mg = 0.0000022 lbs.

o. Step n was repeated to obtain the 90% confidence limits for expected nutrient load in the period of interest, substituting the confidence limits from Step m for the expected value.

p. Total nitrogen (TN) load was calculated as the sum of nitrate (NO3 as N) and total kjeldahl nitrogen (TKN) loads. Few measurements of ortho-phosphates indicated very minimal concentrations; thus, total phosphorous (TP) load was calculated as the total phosphate (PO4 as P) load only.

5.3 Computed Nutrient Loads

Annual nutrient loads are influenced by the spatial and temporal rainfall pattern, watershed area, and the distribution of land uses within the watershed. A nutrient load is computed by multiplying the flow rate by a nutrient concentration (see Section 5.2). In particular, the type of land use has significant influence on the nutrient loads. The goal of the investigation was to estimate the annual and seasonal loads of nutrients to the Upper

Newport Bay/San Diego Creek to compare with TMDL objectives, as well as to observe historical and spatial patterns of the loads in the watershed.

5.3.1 Historical Loads

This section provides a general overview of wet season, dry season, and total annual nutrient loads over the entire period of record at the three selected monitoring stations. Tables 8 through 10 summarize the computed historical nutrient loads. The 1998-99 data (the most recent nutrient data) is compared with the phased TMDL objectives, for the years 2002, 2007, and 2012. Figures 3 through 14 depict the historical nitrogen and phosphorous loads at the three stations as well as a comparison with the TMDL numerical objectives. Tables 11 through 13, provide a summary of total expected, and the 90% confidence upper and lower limits of total nitrogen and phosphorous loads for the three monitoring stations. The following is a brief summary of findings for each of the selected monitoring stations.

<u>San Diego Creek at Culver (Monitoring Station 11)</u>

The historical wet season nitrogen loads at this station indicate many spikes and no recognizable trend over the years examined. However, the dry season and total annual loads indicate a very gradual increasing trend until 1997-98 and then lowering in 1998-99. All computed loads except for dry season nitrogen load in 1997-98 are significantly below the year 2002, 2007 and 2012 TMDL goals for the Newport Bay Watershed.

No general trends were observed in the wet season, dry season, and total annual phosphorous loads computed for San Diego Creek at Culver. A spike in phosphorous loads is observed in 1991-92 and then a general decreasing trend until a second spike in 1997-98. Loads in 1998-99 were reduced substantially. It should be noted that years with higher volumes of flow correspond to much higher phosphorous loads. This validates that the predominant form of phosphorous is particulate which is transported through the watershed in proportion to the flow rate and volume. The computed 1998-99 loads are significantly below 2002 and 2007 TMDL objectives for the Newport Bay Watershed.

<u>San Diego Creek at Campus (Monitoring Station 10)</u>

This station has the longest nitrogen record among all monitoring stations in the watershed. Wet season, dry season, and annual nitrogen loads were computed from 1977-78 to 1998-99. The wet season loads indicate a slightly reducing trend with peaks observed in 1977-78, 1982-83, 1985-86 and 1994-95. All computed total nitrogen loads are above the 2012 TMDL objective. A lowering trend with loads approaching the TMDLs is observed for the period after 1995-96. The computed dry season total nitrogen and nitrate loads are mostly above the year 2002 and 2007 TMDL objectives. However, a general lowering trend is observed and the computed total nitrogen load in 1998-99 approaches 2007 TMDL objective and is below the 2002 limit. The computed total annual loads exhibit a generally decreasing trend. The computed total annual loads are mostly above the 2012 TMDL objective with values nearing the objective in 1998-99.

For this station, phosphorous loads were computed for the period 1977-78 to 1998-99 (the longest record available in the watershed). Except for spikes in 1977-78, 1985-86, 1992-93, 1994-95, and 1997-98, the computed loads are below the 2002 TMDL objective. It should be noted that years with high loads correspond to years with high flow volumes caused by large storm events

Peters Canyon Channel at Barranca Parkway (Monitoring Station 8)

Total nitrogen wet season loads computed for the period between 1985-86 to 1998-99, exhibit a very slight lowering trend. Peaks are observed in 1992-93 and 1996-97. The computed total nitrogen loads are mostly above the 2012 TMDL objective. However, values computed for year 1998-99 are below the objective. The dry season loads show fluctuations, with values exceeding the 2002 TMDL objective for the period prior to 1990-91 and the period after 1996-97. The computed values for the period before 1991-92 and after 1996-97 exceed the 2007 TMDL objective. The total annual nitrogen loads do not exhibit any trends, however a general lowering trend is observed for the period following 1996-97.

The computed phosphorous loads from the year 1985-86 to 1998-99 indicate a very general decreasing trend in the wet season, dry season, and total annual loads. As was the case with the other monitoring stations, years with higher flow volumes exhibited higher phosphorous loads. All computed loads, except for total loads in 1985-86, are below 2002 and 2007 TMDL objectives.

5.3.2 Comparison of Total Nutrient Loads at the Three Selected Monitoring Stations

Table 14 presents a comparison of total nitrogen and phosphorous loads at the three selected monitoring stations for all the years of analysis presented in this report. As expected, San Diego Creek at Campus, which is the most downstream station in the watershed showed the highest phosphorous and nitrogen loads throughout the record. Phosphorous and nitrogen loads in San Diego Creek at Culver were much lower than loads from Peters Canyon Channel at Barranca. Thus, it can be concluded that Peters Canyon Watershed is a significant contributor of nutrient loads in the watershed.

The probable main sources of nutrient loads in the Peters Canyon Watershed could be the three commercial nurseries, tailwater from the irrigation of agricultural crops and ground water. The Regional Board has recommended changes to the waste discharge requirements for these nurseries, and compliance should cause substantial reduction of nutrient loads in the future. Implementation of enhanced irrigation conservation programs will be advantageous in reducing contributing loads from these operations. Continued implementation of the management programs in the three nurseries will aid in further reduction of total nutrient loads in the Peters Canyon Watershed.

5.3.3 Comparison of Current (1998-99) Urban Runoff Nitrogen Loads with the Phased Regional Board TMDL Objectives

This section provides a brief comparison of the current (1998-99) nitrogen loads with the Regional Board TMDLs established for years 2002, 2007 and 2012. These loads were calculated from measured nutrient concentrations at the three selected monitoring stations and include total nitrogen loads from all sources within the watershed. The urban runoff shares of the total computed loads in 1998-1999 were estimated using the percentages presented in Table 1 (ratio of urban runoff to total load allocation).

Table 15 provides a comparison of 1998-1999 wet season, dry season and total annual nitrogen loads from urban runoff with TMDL objectives for the years 2002, 2007 and 2012. As it can be seen, all computed urban runoff nitrogen loads, except for dry season loads in Peters Canyon Channel at Barranca (Station 8), are below the year 2002 TMDL limits established for the Newport Bay Watershed/San Diego Creek (Reach 1). The estimated dry season nitrogen load in Peters Canyon Channel at Barranca is slightly (less than three percent) above the TMDL limit. The 1998-99 dry season nitrogen loads in San Diego Creek at Campus (Station 10) is about 28 percent above and in Peters Canyon at Barranca (Station 8) about 42 percent above the year 2007 TMDL limits. In the year 2012, wet season, dry season and annual loads in San Diego Creek at Campus (Station 10) would be about 11, 28, and 18 percent above the TMDL targets, respectively. Dry season and annual nitrogen loads in Peters Canyon Channel at Barranca (Station 8) would be about 42 and 19 percent above the TMDL limits in the year 2012.

As indicated above, the urban runoff nutrient loads presented in this section are only estimated figures. The estimations were performed due to lack of better source specific nutrient data from urban runoff in the San Diego Creek Watershed and/or similar watersheds in the area. Thus, the results presented shall be treated as general information only and are not to be used in planning and design of BMPs. It is recommended that as part of future monitoring efforts, a commitment be made to characterize nutrient loads from specific sources including urban runoff. Special studies are recommended to better quantify nutrient loads from various sources including urban runoff in the watershed (see Section 6). The nutrient loads presented here shall be reevaluated upon completion of these focused studies and with a better definition of urban runoff nutrient loads within the watershed.

Table 8
Summary of Nutrient Expected Values and Loads for Station 11-San Diego Creek at Culver

Wet Season

Year	Vol. ($L*10^6$)		Expected Value (mg/L)				Loads (1000 lbs)						
Oct-Sep	w/ storm**	w/o storm***	NO3*	NH3*	TKN*	PO4	NO3*	NO3 as N	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	17,663	3,282											
78 - 79	9,009	2,506											
79 - 80	15,352	3,017											
80 - 81	3,850	1,672											
81 - 82	5,613	2,486											
82 - 83	14,037	3,149											
83 - 84	3,720	1,886											
84 - 85	4,884	1,943											
85 - 86	7,041	2,685	26	1	1	6	148	33	4	7	40	96	31
86 - 87	2,109	1,653				2						7	2
87 - 88	3,098	2,206											
88 - 89	3,710	1,789				2						13	4
89 - 90	2,913	1,515	55	1	3	4	185	42	3	10	52	23	7
90 - 91	6,867	2,260											
91 - 92	13,777	2,088	73	0	1	18	334	75	1	7	82	545	178
92 - 93	25,949	3,123	40	0	1	6	273	62	1	8	69	338	110
93 - 94	3,866	1,627	70	0	2	3	281	63	1	7	70	27	9
94 - 95	18,907	3,499	28	0	4	3	215	49	2	33	82	113	37
95 - 96	8,112	2,200	79	0	1	3	384	87	1	7	94	46	15
96 - 97	12,224	2,253	42	0	2	2	207	47	1	8	55	63	21
97 - 98	36,224	4,679	32	0	2	3	329	74	2	17	91	273	89
98 - 99	4,454	2,543	44	0	2	2	248	56	1	13	69	15	5

Dry Season

Year	Vol. ($L*10^6$)		Expected Value (mg/L)				Loads (1000 lbs)						
Oct-Sep	w/ storm	w/o storm***	NO3	NH3	TKN	PO4	NO3	NO3 as N	NH3	TKN	TN	PO4	PO4 as P
77 - 78	2,113	1,218											
78 - 79	817	817											
79 - 80	938	938											
80 - 81	920	920											
81 - 82	1,543	1,543											
82 - 83	3,136	1,617											
83 - 84	1,062	1,062											
84 - 85	1,190	1,189											
85 - 86	2,143	1,556											
86 - 87	1,022	1,019											
87 - 88	1,364	952											
88 - 89	899	892	85	1	3	3	168	38	2	6	44	6	2
89 - 90	815	815	33				60	14					
90 - 91	572	573	60	0	2	3	75	17	0	2	19	3	1
91 - 92	747	747	68	0	1	1	112	25	0	2	27	2	1
92 - 93	1,694	1,228	47	0	1	1	174	39	1	4	43	4	1
93 - 94	1,131	837	70	0	2	1	175	39	1	6	45	3	1
94 - 95	1,509	1,258	70	0	2	2	231	62	0	6	58	4	1
95 - 96	715	602	96	0	1	0	110	25	0	2	26	3	1
96 - 97	795	564	89	0	1	1	168	38	0	2	40	0	0
97 - 98	3,710	1,464	78	0	3	1	723	163	2	27	190	5	2
98 - 99	2,336	1,277	72	0	1	1	401	91	0	4	95	3	1

Annual

Year	Vol. ($L*10^6$)		Loads (1000 lbs)						
Oct-Sep	w/ storm	w/o storm***	NO3*	NO3 as N*	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	19,766	4,500							
78 - 79	9,826	3,323							
79 - 80	16,289	3,956							
80 - 81	4,770	2,592							
81 - 82	7,156	4,028							
82 - 83	17,172	4,766							
83 - 84	4,783	2,948							
84 - 85	6,074	3,132							
85 - 86	9,184	4,141							
86 - 87	3,131	2,672							
87 - 88	4,463	3,157							
88 - 89	4,610	2,681						19	6
89 - 90	3,727	2,330	245	55	3	10	52		
90 - 91	7,440	2,833							
91 - 92	14,524	2,836	447	101	1	8	109	547	178
92 - 93	27,643	4,351	447	101	2	11	112	342	112
93 - 94	4,999	2,664	456	103	1	12	115	30	10
94 - 95	20,416	4,757	447	101	2	39	140	117	38
95 - 96	8,827	2,802	493	111	1	9	120	50	16
96 - 97	13,019	2,817	376	85	2	10	96	64	21
97 - 98	39,934	6,133	1,052	238	4	43	281	278	91
98 - 99	6,789	3,820	649	147	1	17	164	19	6

Key:

(shaded)	Nutrient Data not Available
*	Excluding nutrient readings from days on which flows resulting from precipitation exceeded 25 cfs (approximate flow on days for which flow at Station 10 exceeded 50 cfs according to regression analysis)
**	Flows used for wet season Nitrogen loads
***	Flows used for wet season Phosphorus loads and all dry season loads
264	Flow volumes estimated based on rainfall regression
42	No daily flow data available to exclude storm readings

Table 9
Summary of Nutrient Expected Values and Loads for Station 10-San Diego Creek at Campus

Wet Season

Year	Vol. (L*10^6) w/ storm	Vol. (L*10^6) w/o storm**	Expected Value (mg/L) NO3*	NH3*	TKN*	PO4	Loads (1000 lbs) NO3*	NO3 as N*	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	60,666	12,674	132	6	13	4	3,683	832	162	375	1,206	493	161
78 - 79	34,086	11,471	59	0	3	2	1,497	338	8	69	407	124	40
79 - 80	48,311	12,748	59	0	3	2	1,663	376	8	77	452	176	57
80 - 81	18,478	9,629	42	1	5	2	900	203	26	104	308	69	23
81 - 82	24,521	11,689	37	0	3	3	949	214	10	77	292	187	61
82 - 83	61,043	13,461	76	2	4	1	2,252	509	46	124	633	192	63
83 - 84	21,527	13,580	40	1	2	1	1,209	273	33	47	320	56	18
84 - 85	24,845	14,573	56	1	1	2	1,782	402	21	32	434	94	31
85 - 86	28,290	14,637	138	1	3	5	4,444	1,004	25	111	1,115	339	111
86 - 87	15,132	10,653	79	1	2	4	1,832	414	16	38	452	123	40
87 - 88	15,905	8,967	53	0	1	3	1,036	234	3	21	255	88	29
88 - 89	17,080	8,037	86	2	3	2	1,520	343	44	56	399	68	22
89 - 90	15,763	10,118	64	0	1	4	1,425	322	7	24	346	136	44
90 - 91	29,642	7,465											
91 - 92	40,275	8,219	98	1	1	2	1,769	399	9	13	413	164	54
92 - 93	69,113	9,991	63	0	1	4	1,391	314	5	23	337	629	206
93 - 94	18,064	7,207	65	0	1	2	1,039	235	3	20	254	74	24
94 - 95	65,458	10,640	104	0	1	2	2,426	548	6	15	563	300	98
95 - 96	22,364	8,109	78	0	1	2	1,392	314	5	17	331	110	36
96 - 97	32,761	9,078	48	1	2	3	965	218	18	41	259	211	69
97 - 98	97,641	12,892	29	0	2	4	824	186	9	56	242	921	300
98 - 99	12,670	6,301	42	0	2	1	584	132	4	31	162	26	9

Dry Season

Year	Vol. (L*10^6) w/ storm	Vol. (L*10^6) w/o storm**	Expected Value (mg/L) NO3	NH3	TKN	PO4	Loads (1000 lbs) NO3	NO3 as N	NH3	TKN	TN	PO4	PO4 as P
77 - 78	13,419	10,249	70	1	4	4	2,063	466	23	127	593	110	36
78 - 79	11,428	11,428	48	1	3	2	1,218	275	20	77	352	43	14
79 - 80	7,563	7,563	60	1	4	4	1,336	302	16	73	374	59	19
80 - 81	7,439	7,439	101	2	4	3	1,657	374	30	61	435	49	16
81 - 82	10,222	7,931	118	3	4	2	2,650	598	73	82	681	46	15
82 - 83	19,934	14,586	69	2	5	1	3,047	688	77	199	887	46	15
83 - 84	12,459	12,207	63	2	4	3	1,715	387	45	104	491	69	23
84 - 85	12,074	12,019	117	4	4	3	3,103	701	100	106	807	85	28
85 - 86	14,287	12,362	44	1	1	6	1,381	312	16	41	353	185	60
86 - 87	9,046	8,990	130	1	2	4	2,587	584	14	32	616	84	27
87 - 88	10,939	8,478	129	6	5	5	3,113	703	133	110	813	126	41
88 - 89	8,265	9,353	115	3	4	4	2,096	473	57	80	553	64	21
89 - 90	7,669	8,179	64	1	1	2	1,088	246	16	21	267	27	9
90 - 91	5,469	5,439	72	0	1	5	872	197	1	16	213	58	19
91 - 92	5,133	4,872	56	0	1	1	634	143	3	15	158	10	3
92 - 93	11,152	7,202	65	0	1	1	1,584	358	7	25	383	16	5
93 - 94	6,531	6,019	66	0	1	1	951	215	4	16	231	14	4
94 - 95	10,458	8,336	49	0	1	1	1,136	256	6	31	287	19	6
95 - 96	6,282	6,965	59	0	1	1	814	184	3	15	199	9	3
96 - 97	5,924	6,382	46	0	2	1	602	136	3	30	166	14	4
97 - 98	13,891	8,609	46	0	2	1	1,415	319	2	70	390	27	9
98 - 99	8,715	7,088	36	0	2	1	696	157	5	35	193	13	4

Annual

Year	Vol. (L*10^6) w/ storm	Vol. (L*10^6) w/o storm**	Loads (1000 lbs) NO3*	NO3 as N*	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	74,086	22,923	5,745	1,297	186	501	1,799	603	197
78 - 79	45,514	22,899	2,715	613	28	146	759	167	54
79 - 80	55,874	20,311	2,999	677	25	149	826	234	76
80 - 81	25,857	17,068	2,557	577	56	165	743	118	38
81 - 82	34,744	19,620	3,599	813	84	160	972	233	76
82 - 83	80,977	28,047	5,299	1,197	123	323	1,520	238	78
83 - 84	33,986	25,787	2,924	660	79	150	810	125	41
84 - 85	36,919	26,591	4,884	1,103	120	138	1,241	179	58
85 - 86	42,557	26,989	5,826	1,315	41	152	1,468	524	171
86 - 87	24,178	19,642	4,419	998	30	70	1,068	207	67
87 - 88	26,444	17,345	4,149	937	137	131	1,067	214	70
88 - 89	25,344	17,390	3,616	816	101	135	952	132	43
89 - 90	23,432	18,296	2,513	567	22	46	613	163	53
90 - 91	35,110	12,905							
91 - 92	45,408	13,091	2,403	543	12	28	571	174	57
92 - 93	80,265	17,194	2,975	672	11	48	720	645	211
93 - 94	24,595	13,227	1,990	449	7	36	485	88	29
94 - 95	75,916	18,976	3,560	804	12	46	850	319	104
95 - 96	28,646	14,073	2,206	498	7	32	530	119	39
96 - 97	38,685	14,460	1,567	354	21	71	424	224	73
97 - 98	111,532	21,501	2,239	506	11	126	632	948	309
98 - 99	21,385	13,389	1,280	289	9	66	355	41	13

Key:

(grey)	Nutrient Data not Available
*	Excluding nutrient readings from days on which flows exceeded 50 cfs as a result of precipitation
**	Flows used for wet season Nitrogen loads
***	Flows used for wet season Phosphorus loads and all dry season loads
264	Flow volumes estimated based on rainfall regression
42	No daily flow data available to exclude storm readings

Table 10
Summary of Nutrient Expected Values and Loads for Station 8-Peters Canyon Channel at Barranca

Wet Season

Year	Vol. ($L*10^6$) w/ storm	Vol. ($L*10^6$) w/o storm**	Expected Value (mg/L) NO3*	NH3*	TKN*	PO4	Loads (1000 lbs) NO3*	NO3 as N*	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	22,142	6,492											
78 - 79	13,492	6,664											
79 - 80	19,677	6,195											
80 - 81	7,940	5,037											
81 - 82	9,914	5,092											
82 - 83	18,516	6,089											
83 - 84	7,772	4,976											
84 - 85	9,046	4,967											
85 - 86	11,372	6,494	310	0	2	5	4429	1000	6	21	1022	221	72
86 - 87	7,123	5,987				2						68	22
87 - 88	8,130	5,231											
88 - 89	8,531	4,764				3						47	15
89 - 90	6,889	5,009	63	0	2	3	697	157	4	21	179	64	21
90 - 91	11,016	5,184											
91 - 92	15,090	3,866	73	0	0	7	623	141	2	4	144	113	37
92 - 93	31,624	5,421	90	0	1	3	1068	241	4	11	252	53	17
93 - 94	8,391	4,042	39	0	1	3	343	77	1	7	85	66	21
94 - 95	22,401	5,715	42	0	2	1	528	119	4	29	148	18	6
95 - 96	7,083	3,858	67	0	4	1	482	109	4	31	140	26	8
96 - 97	12,925	4,960	95	1	3	2	1040	235	6	27	262	36	12
97 - 98	36,643	6,400	41	0	2	5	576	130	5	31	161	69	23
98 - 99	6,148	3,900	69	0	3	2	503	114	3	28	141	60	20

Dry Season

Year	Vol. ($L*10^6$) w/ storm	Vol. ($L*10^6$) w/o storm	Expected Value (mg/L) NO3	NH3	TKN	PO4	Loads (1000 lbs) NO3	NO3 as N	NH3	TKN	TN	PO4	PO4 as P
77 - 78	5973	4651											
78 - 79	4424	4424											
79 - 80	4589	4589											
80 - 81	4561	4561											
81 - 82	5331	4532											
82 - 83	7123	4868											
83 - 84	4752	4540											
84 - 85	6335	6253											
85 - 86	7501	6931											
86 - 87	5823	5696											
87 - 88	5750	4614											
88 - 89	4405	4406	109	6	13	3	1052	237	59	126	363	33	11
89 - 90	4421	4421	96				936	211					
90 - 91	3559	3559	104	0	1	3	812	183	1	5	189	27	9
91 - 92	3062	3067	72	0	1	1	486	109	1	6	115	5	2
92 - 93	4702	4102	56	0	1	0	579	131	1	10	141	5	2
93 - 94	3751	3598	43	0	1	2	356	80	2	9	90	15	5
94 - 95	4160	3661	63	0	1	1	576	130	2	11	141	7	2
95 - 96	3450	3379	82	0	2	1	623	141	3	12	152	8	3
96 - 97	3367	3293	88	0	3	2	654	148	2	20	168	13	4
97 - 98	5946	4463	83	0	1	1	1079	244	2	18	262	11	4
98 - 99	4841	4433	81	0	2	1	864	195	2	19	214	9	3

Annual

Year	Vol. ($L*10^6$) w/ storm	Vol. ($L*10^6$) w/o storm	Loads (1000 lbs) NO3*	NO3 as N*	NH3*	TKN*	TN*	PO4	PO4 as P
77 - 78	28115	11143							
78 - 79	17906	10088							
79 - 80	24266	10783							
80 - 81	12501	9598							
81 - 82	15245	9624							
82 - 83	25638	10958							
83 - 84	12524	9516							
84 - 85	15380	11214							
85 - 86	18874	13426							
86 - 87	12946	11683							
87 - 88	13879	9844							
88 - 89	12936	9170						80	26
89 - 90	11311	9430	1633	369					
90 - 91	14575	8744							
91 - 92	18171	6931	1108	250	3	9	260	118	39
92 - 93	36326	9523	1646	372	5	20	392	58	19
93 - 94	12142	7600	698	158	4	17	174	81	26
94 - 95	26561	9376	1104	249	6	40	289	25	8
95 - 96	10533	7237	1106	250	6	42	292	33	11
96 - 97	16312	8253	1694	382	8	48	430	49	16
97 - 98	42589	10863	1656	374	6	49	423	80	26
98 - 99	10989	8332	1366	309	6	47	356	69	23

Key:

(shaded) Nutrient Data not Available

* Excluding nutrient readings from days on which flows resulting from precipitation exceeded 25 cfs (approximate flow for days on which flows exceeded 50 cfs at Station 10 according to regression analysis)

** Flows used for wet season Nitrogen loads

*** Flows used for wet season Phosphorus loads and all dry season loads

284 Flow volumes estimated based on rainfall regression

42 No daily flow data available to exclude storm readings

Figure 3
Wet Season Nitrogen Loads Station 11-San Diego Creek at Culver

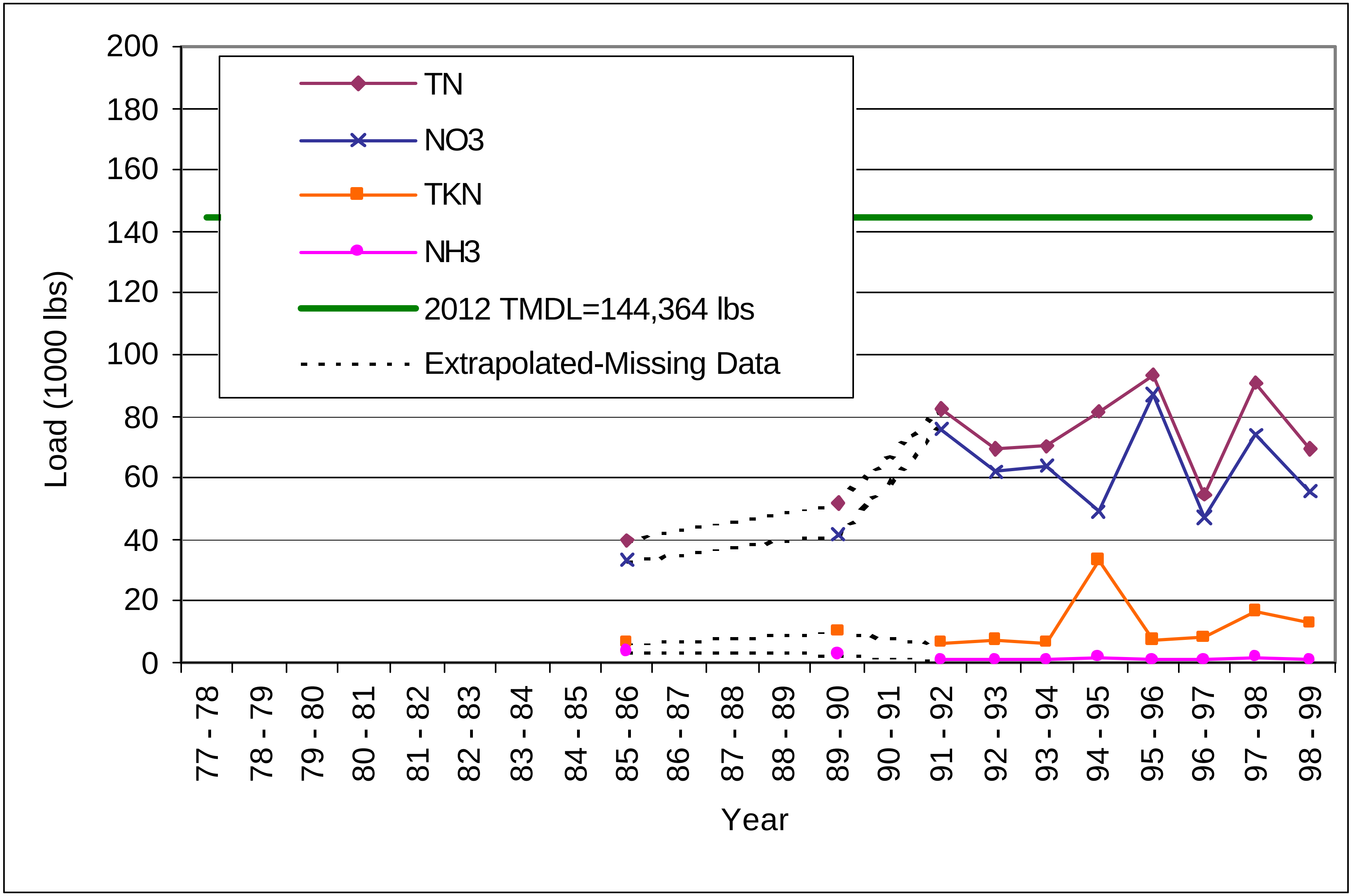


Figure 4
Dry Season Nitrogen Loads Station 11-San Diego Creek at Culver

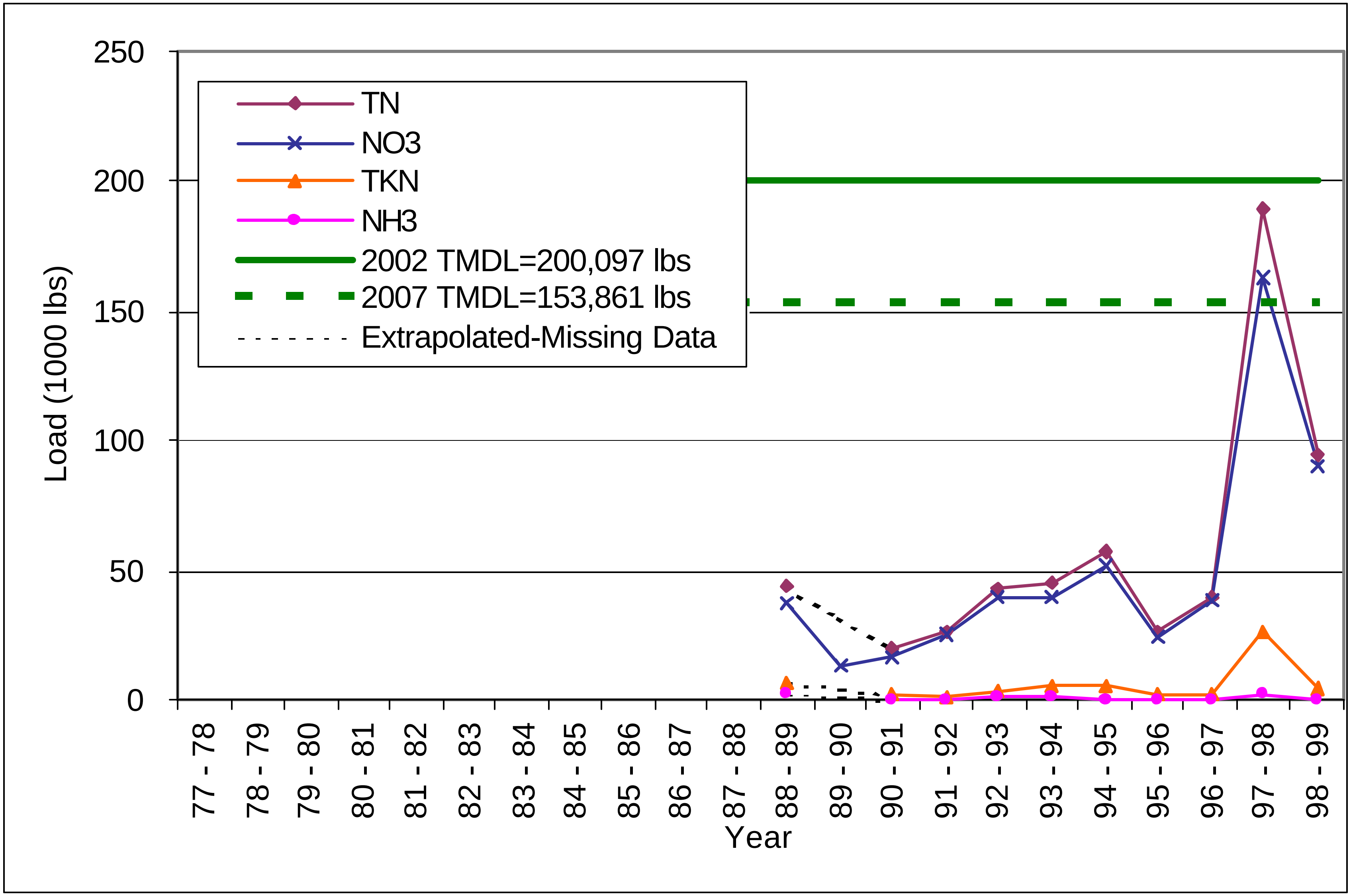


Figure 5
Annual Nitrogen Loads Station 11-San Diego Creek at Culver

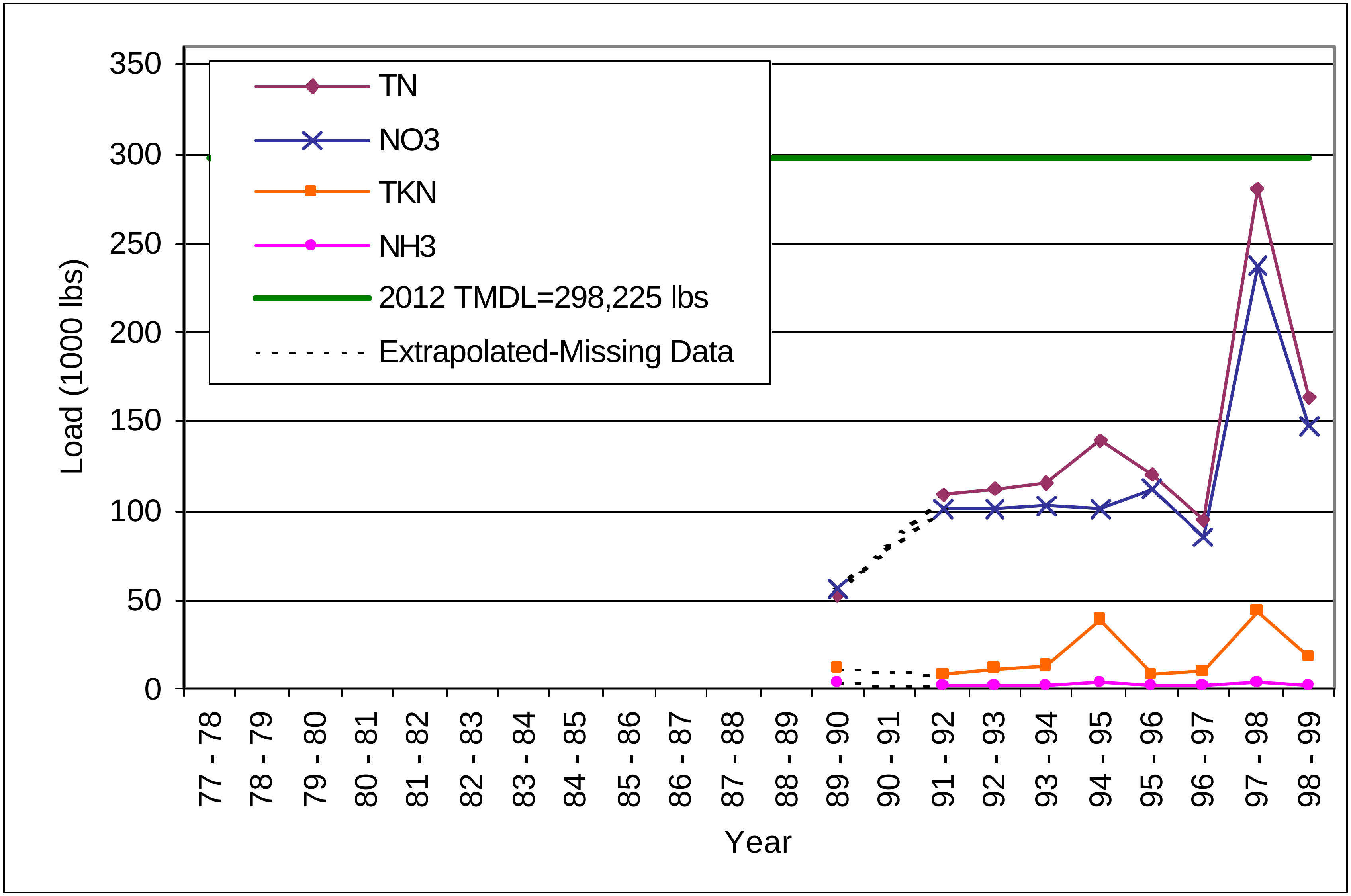


Figure 6
Total Phosphorus Loads Station 11-San Diego Creek at Culver

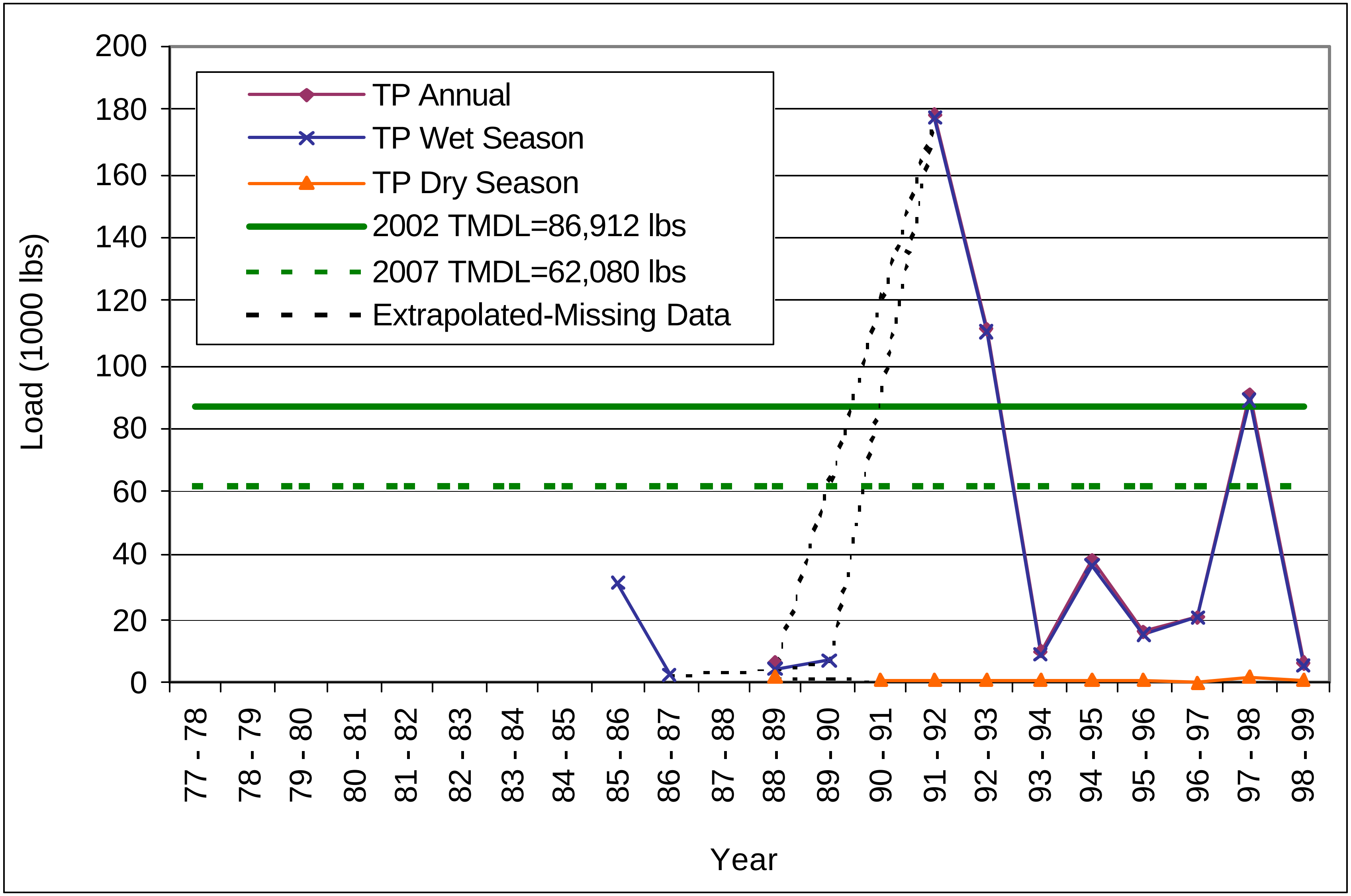


Figure 7
Wet Season Nitrogen Loads Station 10-San Diego Creek at Campus

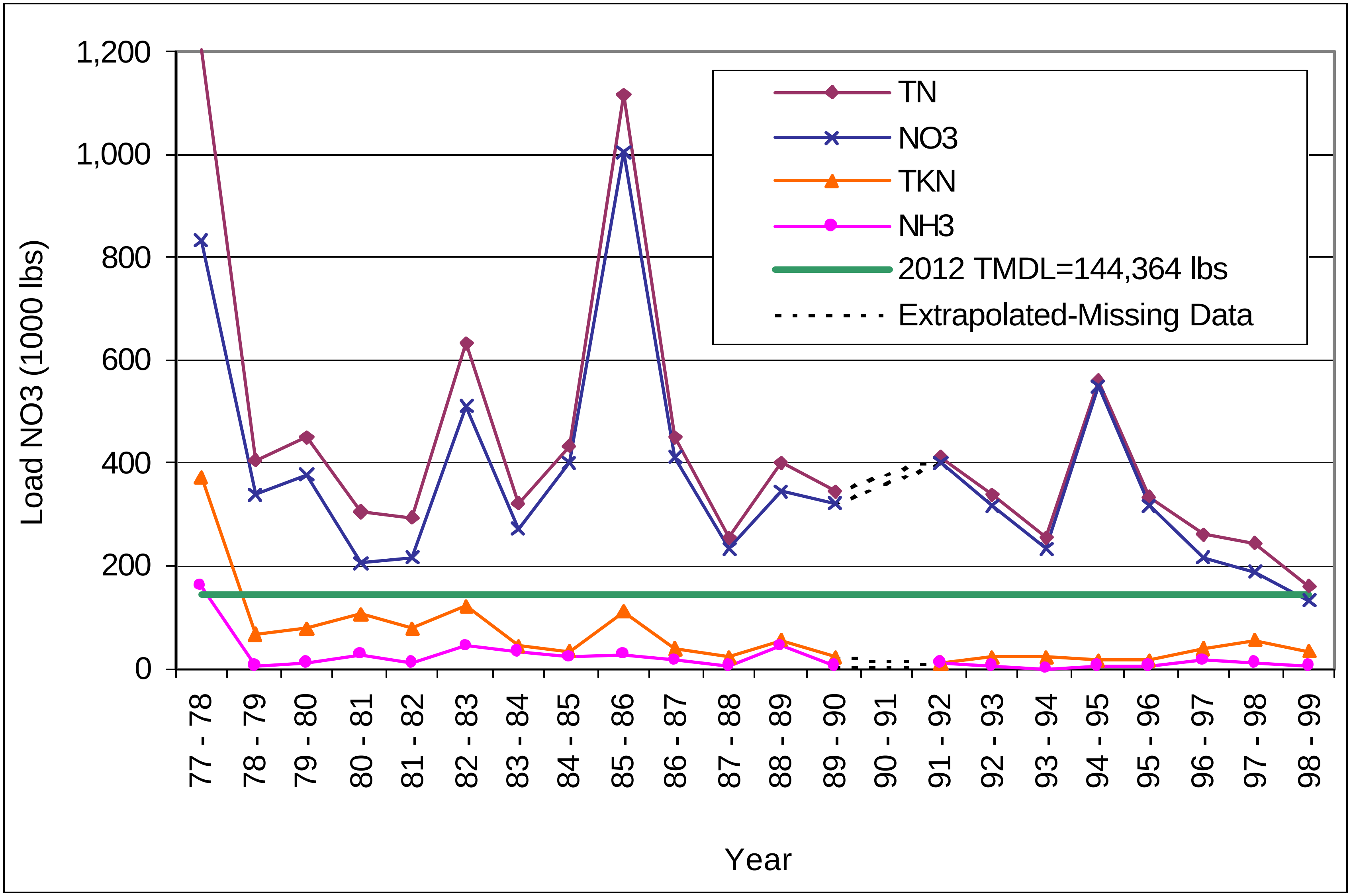


Figure 8
Dry Season Nitrogen Loads Station 10-San Diego Creek at Campus

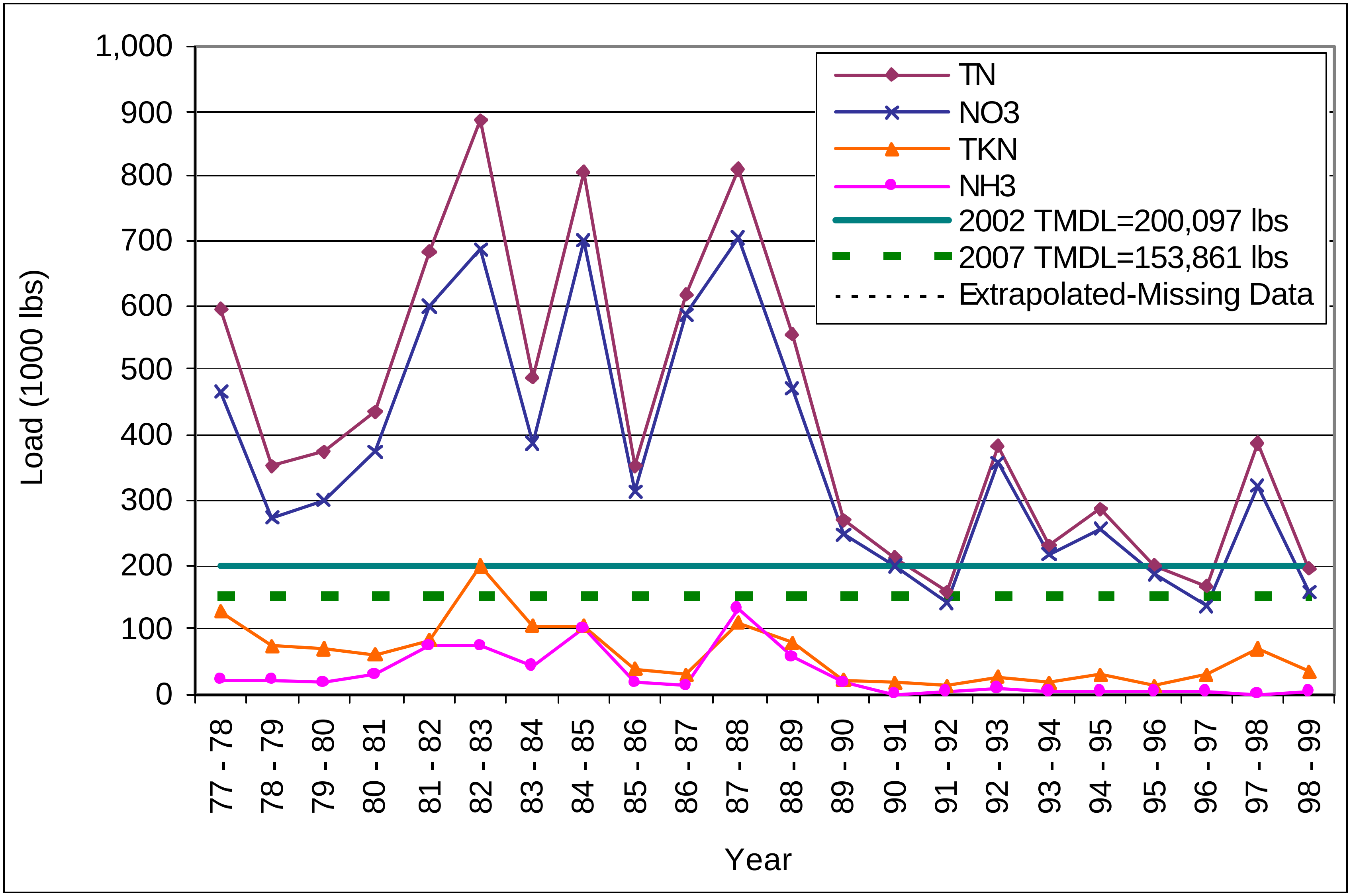


Figure 9
Annual Nitrogen Loads Station 10-San Diego Creek at Campus

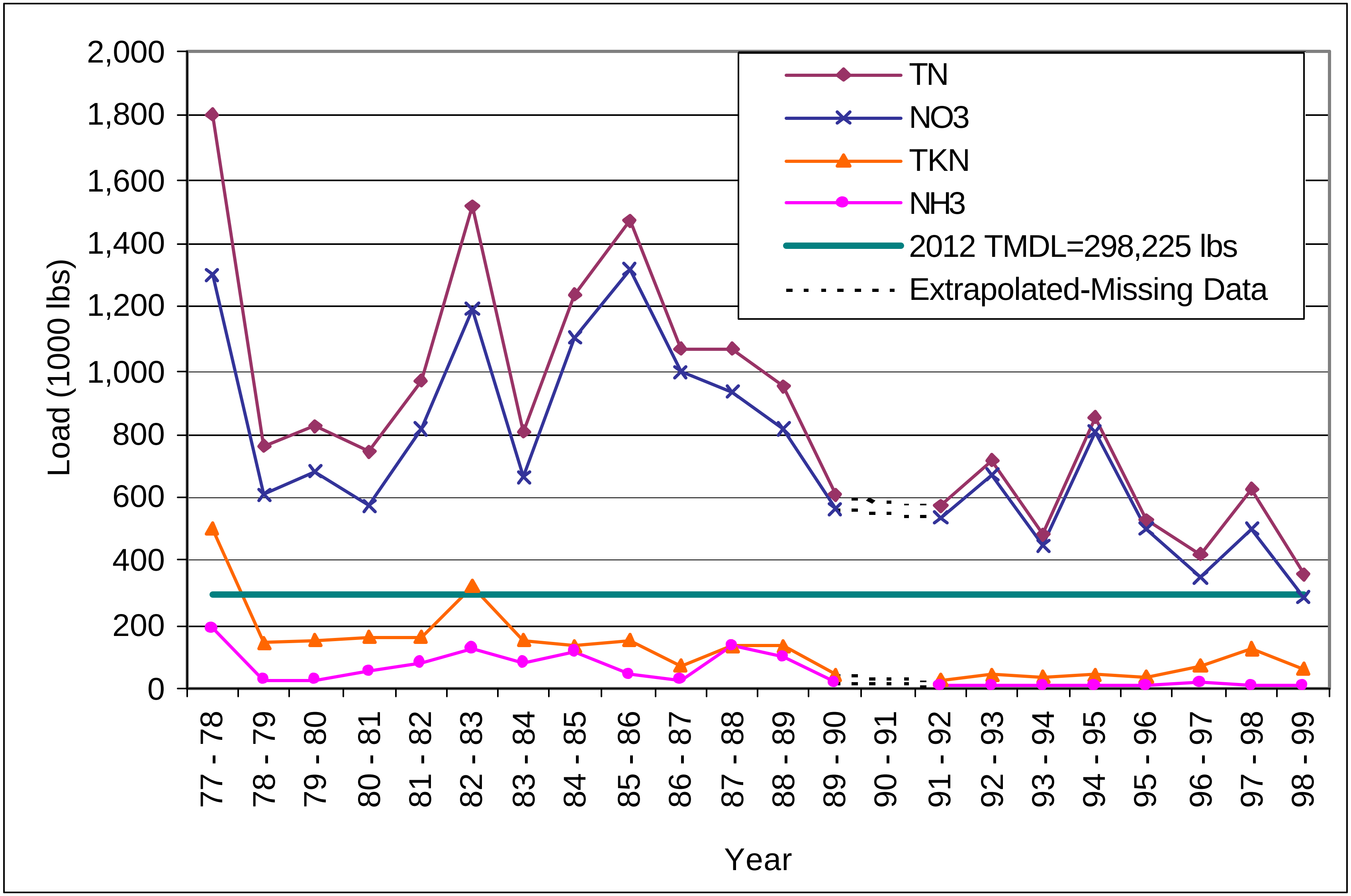


Figure 10
Total Phosphorus Loads Station 10-San Diego Creek at Campus

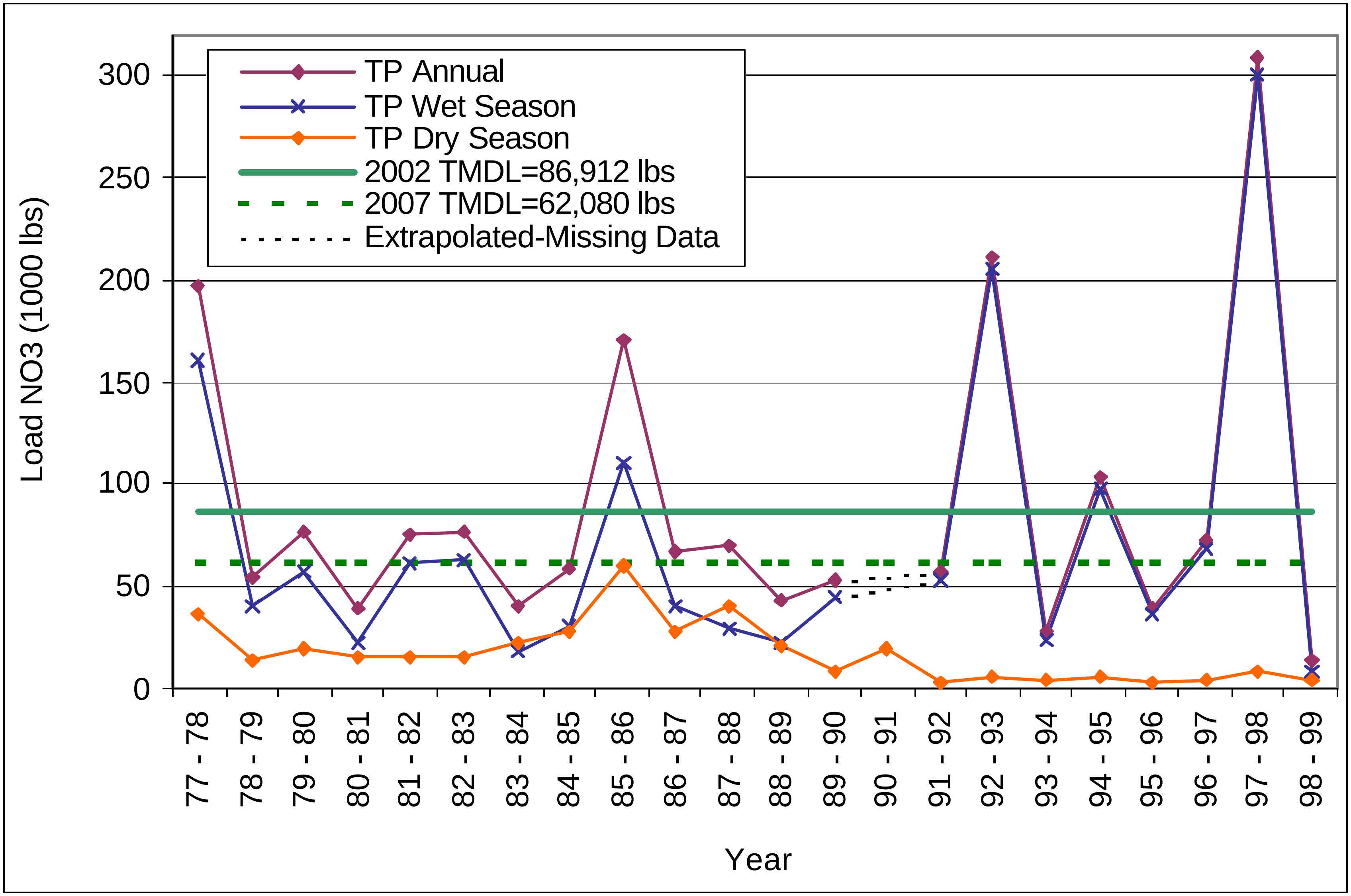


Figure 11
Wet Season Nitrogen Loads Station 8 - Peters Canyon Channel at Barranca

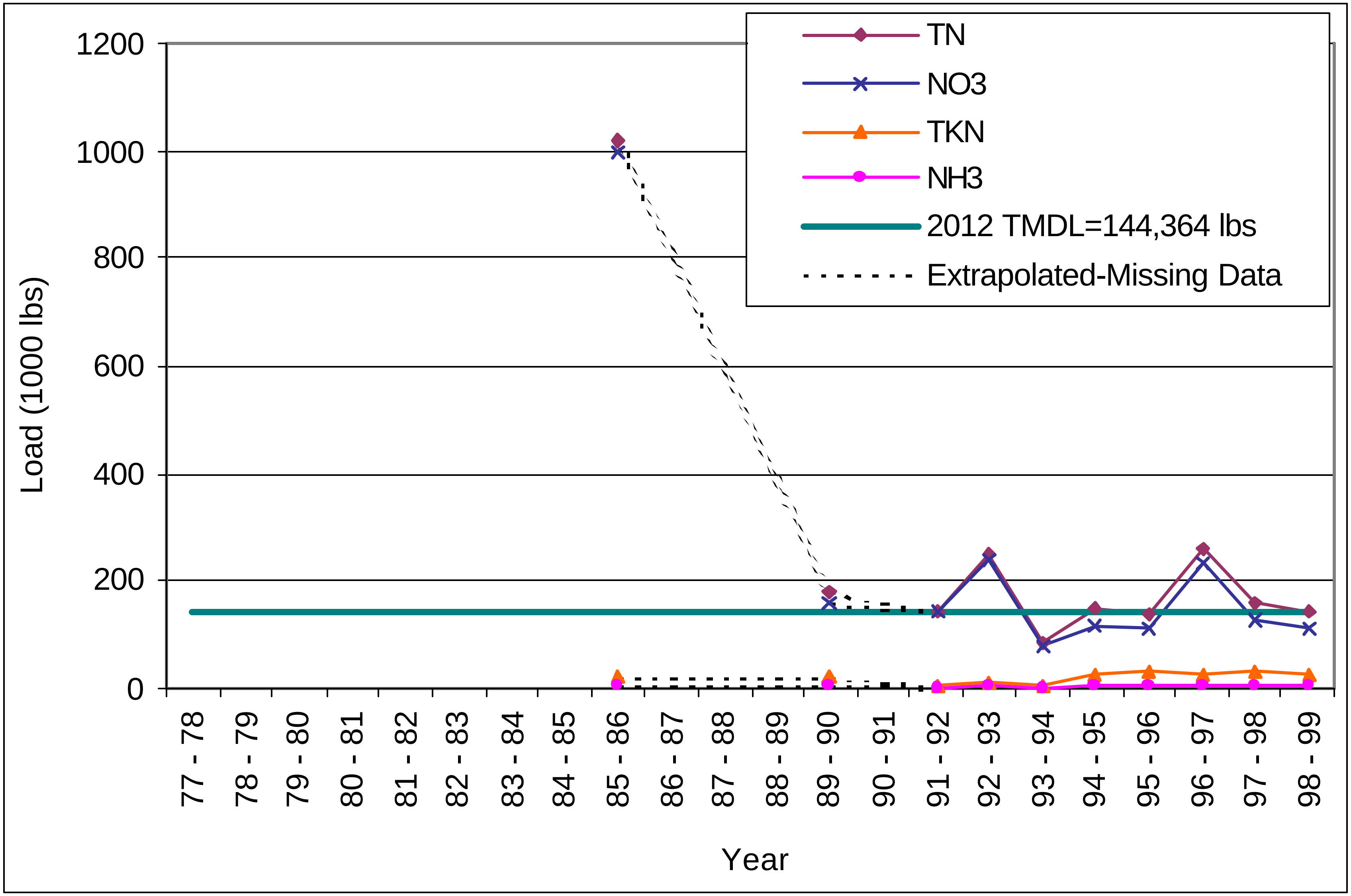


Figure 12
Dry Season Nitrogen Loads Station 8 -Peters Canyon Channel at Barranca

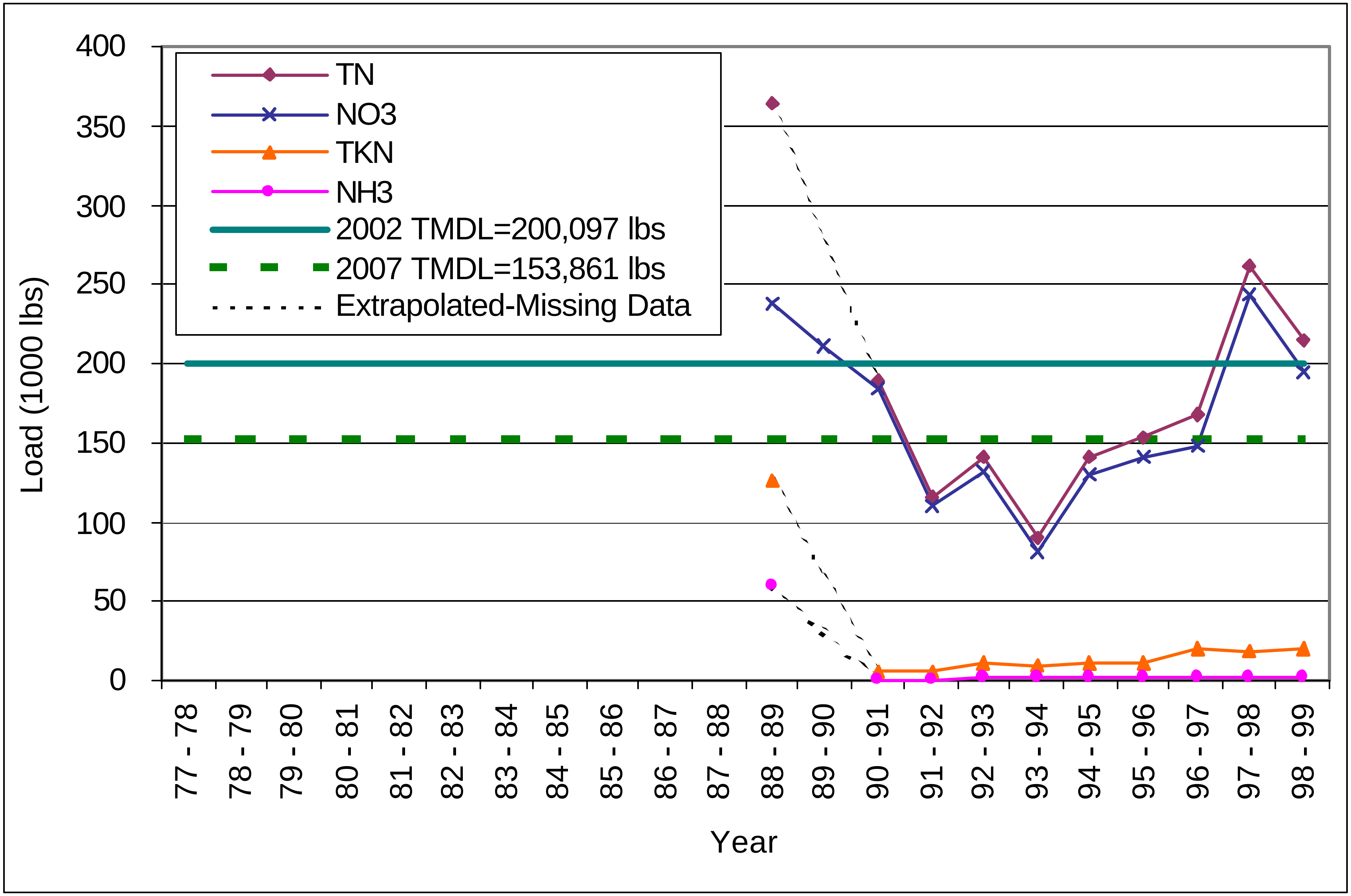


Figure 13
Annual Nitrogen Loads Station 8 -Peters Canyon Channel at Barranca

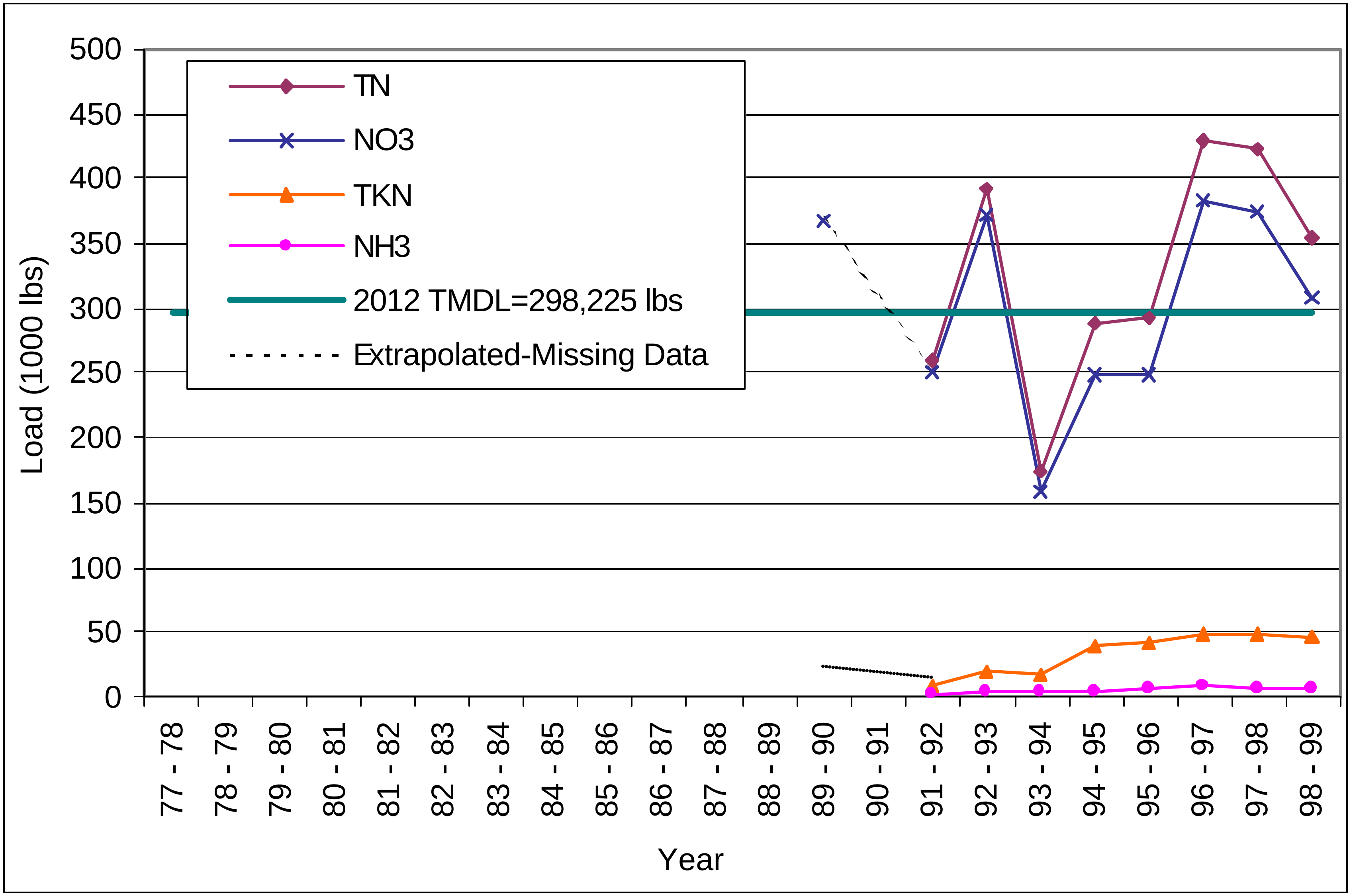


Figure 14
Total Phosphorous Loads Station 8 -Peters Canyon Channel at Barranca

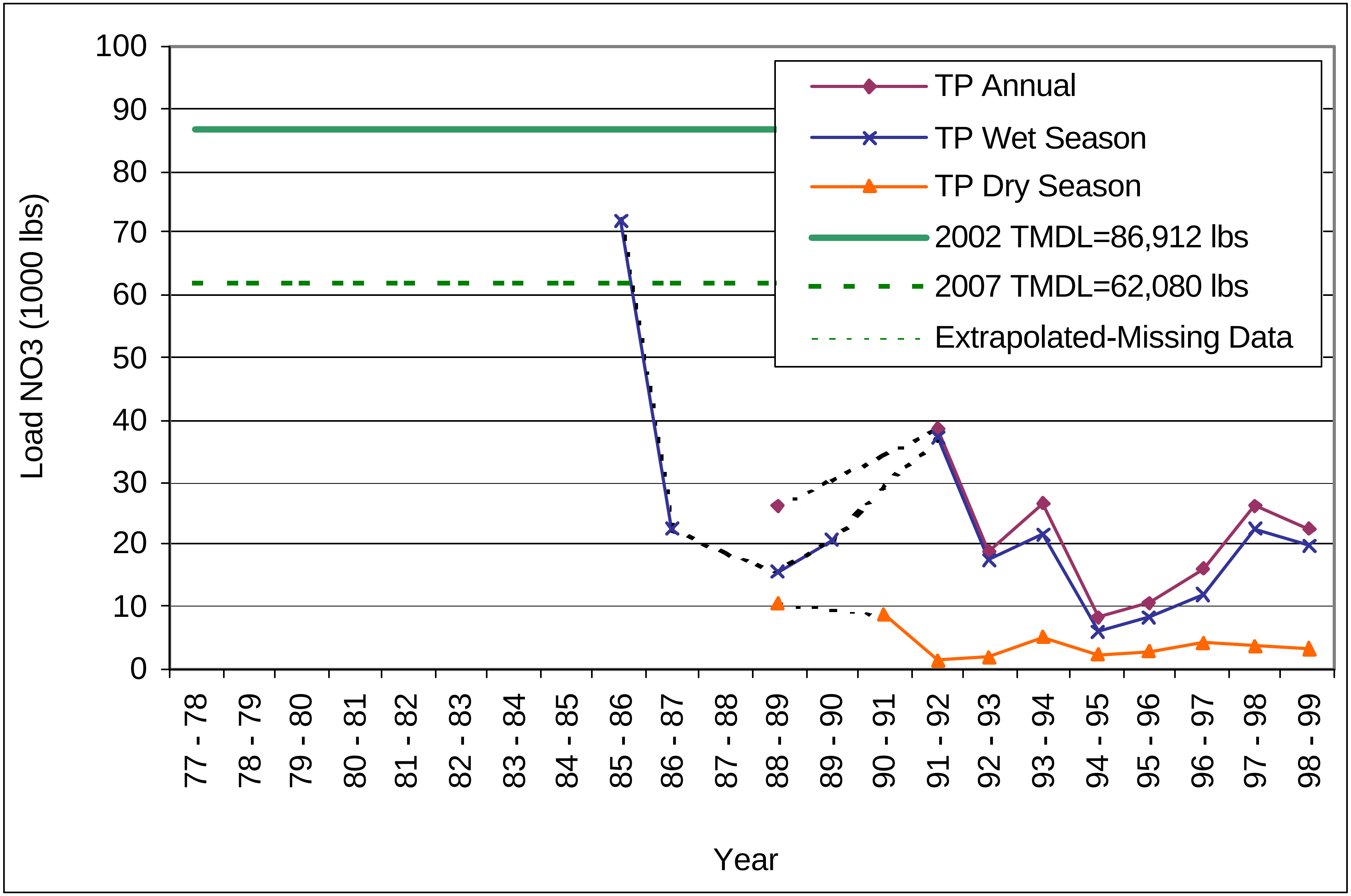


Table 11
90% Confidence Limit Total Nitrogen and Total Phosphorus Loads at Station 11-San Diego Creek at Culver

Year	Loads (1,000 lbs)*																	
	Wet Season						Dry Season						Total Annual					
	Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**		
	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi
77 - 78																		
78 - 79																		
79 - 80																		
80 - 81																		
81 - 82																		
82 - 83																		
83 - 84																		
84 - 85																		
85 - 86	40	***	***	31	***	***												
86 - 87				2	***	***												
87 - 88																		
88 - 89				4	***	***	44	***	***	1.8	0.8	3.2				6	***	***
89 - 90	52	20	95	7	5	11												
90 - 91							19	9	33	1.1	0.6	1.7						
91 - 92	82	31	149	178	39	373	27	17	38	0.6	0.2	1.2	109	49	187	178	39	374
92 - 93	69	27	125	110	29	222	43	31	56	1.1	0.5	2.0	112	58	180	112	30	224
93 - 94	70	31	120	9	2	19	45	21	75	0.9	0.1	2.0	115	52	195	10	2	21
94 - 95	82	21	166	37	10	75	58	38	81	1.2	0.5	4.6	140	59	247	38	10	79
95 - 96	94	46	153	15	4	30	26	26	47	1.0	0.1	0.2	120	73	199	16	4	30
96 - 97	55	19	103	21	7	39	40	27	47	0.1	0.2	0.5	95	47	150	21	7	40
97 - 98	91	41	155	89	26	176	190	72	298	1.5	0.5	3.5	281	113	453	91	26	179
98 - 99	69	36	111	5	1	10	95	72	104	1.1	0.3	2.6	164	108	214	6	2	13

Key:

(shaded)	Nutrient Data not Available
*	Event Mean Concentration used after 1994 for load calculating for qualified storm events
**	exp: Expected Value
**	90% lo: Lower 90% Confidence Limit
**	90% hi: Upper 90% Confidence Limit
***	expected value equal to single data point - confidence limits not computed

Table 12
90% Confidence Limit Total Nitrogen and Total Phosphorus Loads at Station 10-San Diego Creek at Campus

Year	Loads (1,000 lbs)*																	
	Wet Season						Dry Season						Total Annual					
	Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**		
	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi
77 - 78	1206	552	2034	161	32	342	593	593	1029	36	36	75	1799	1144	3063	197	68	417
78 - 79	407	200	664	40	7	88	352	133	639	14	4	29	759	333	1303	54	11	116
79 - 80	452	150	688	57	14	108	374	374	471	19	19	37	826	524	1160	76	34	145
80 - 81	308	158	491	23	4	49	435	231	685	16	7	27	743	389	1176	38	11	76
81 - 82	292	129	500	61	25	108	681	470	930	15	6	27	972	599	1430	76	31	135
82 - 83	633	279	1085	63	30	104	887	377	1544	15	7	24	1520	657	2629	78	37	128
83 - 84	320	100	617	18	4	38	491	233	825	23	13	35	810	333	1442	41	17	72
84 - 85	434	129	849	31	9	60	807	***	***	28	***	***	1241	***	***	58	***	***
85 - 86	1115	220	2378	111	67	163	353	***	***	60	***	***	1468	***	***	171	***	***
86 - 87	452	205	764	40	14	75	616	***	***	27	***	***	1068	***	***	67	***	***
87 - 88	255	164	361	29	12	51	813	478	1215	41	30	54	1067	641	1575	70	41	105
88 - 89	399	192	660	22	18	27	553	373	761	21	14	29	952	565	1421	43	32	56
89 - 90	346	346	346	44	20	75	267	201	343	9	8	10	613	547	689	53	28	85
90 - 91							213	125	320	19	2	43						
91 - 92	413	316	519	54	46	62	158	112	211	3	2	5	571	428	731	57	48	67
92 - 93	337	239	448	205	55	411	383	279	499	5	2	9	720	518	946	211	58	421
93 - 94	254	156	370	24	7	47	231	163	307	4	3	7	485	319	677	29	10	53
94 - 95	563	303	880	98	13	219	287	210	373	6	3	10	850	513	1254	104	16	229
95 - 96	331	297	368	36	5	80	199	112	304	3	2	4	530	408	672	39	7	83
96 - 97	259	115	442	69	10	153	166	80	273	4	2	8	424	195	715	73	11	161
97 - 98	242	122	390	300	87	593	390	200	624	9	3	17	632	322	1015	309	90	609
98 - 99	162	81	264	9	2	19	193	107	297	4	2	7	355	187	560	13	4	26

Key:

(shaded)	Nutrient Data not Available
*	Event Mean Concentration used after 1997 for load calculation for qualified storm events
**	exp: Expected Value
**	90% lo: Lower 90% Confidence Limit
**	90% hi: Upper 90% Confidence Limit
***	expected value equal to single data point - confidence limits not computed

Table 13
90% Confidence Limit Total Nitrogen and Total Phosphorus Loads at Station 8-Peters Canyon Channel at Barranca

Year	Loads (1,000 lbs)*																	
	Wet Season						Dry Season						Total Annual					
	Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**			Total Nitrogen**			Total Phosphorus**		
	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi	exp	90% lo	90% hi
77 - 78																		
78 - 79																		
79 - 80																		
80 - 81																		
81 - 82																		
82 - 83																		
83 - 84																		
84 - 85																		
85 - 86	1022	***		72	***													
86 - 87				22	***													
87 - 88																		
88 - 89				15	***		363	286	452	11	9	12				26	***	
89 - 90	179	107	263	21	8	23												
90 - 91							189	94	306	9	1	19						
91 - 92	144	125	165	37	11	158	115	68	171	2	1	2	260	193	336	39	12	160
92 - 93	252	148	375	17	12	129	141	62	241	2	1	3	392	210	616	19	12	132
93 - 94	85	32	153	21	2	36	90	43	148	5	1	11	174	75	302	26	3	47
94 - 95	148	94	211	6	10	28	141	98	190	2	1	4	289	192	402	8	11	31
95 - 96	140	69	230	8	2	14	152	94	221	3	1	5	292	163	451	11	3	19
96 - 97	262	110	459	12	5	35	168	126	217	4	2	7	430	236	676	16	8	42
97 - 98	161	70	279	23	29	247	262	186	348	4	2	6	423	256	627	26	31	252
98 - 99	141	59	244	20	4	21	214	141	298	3	2	5	356	201	542	23	5	25

Key:

(shaded)	Nutrient Data not Available
*	Event Mean Concentration used after 1994 for load calculations for qualified storm events
**	exp: Expected Value
**	90% lo: Lower 90% Confidence Limit
**	90% hi: Upper 90% Confidence Limit
***	expected value equal to single data point - confidence limits not computed

Table 14
Comparison of Nutrient Loads at the Three Selected Monitoring Stations

	Loads (1000 lbs)																	
	Station 11: San Diego Creek @ Culver						Station 10: San Diego Creek @ Campus						Station 8: Peters Canyon Ch. @ Barranca					
Year	Wet Season		Dry Season		Total Annual		Wet Season		Dry Season		Total Annual		Wet Season		Dry Season		Total Annual	
	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP	TN	TP
77 - 78							1206	161	593	36	1799	197						
78 - 79							407	40	352	14	759	54						
79 - 80							452	57	374	19	826	76						
80 - 81							308	23	435	16	743	38						
81 - 82							292	61	681	15	972	76						
82 - 83							633	63	887	15	1520	78						
83 - 84							320	18	491	23	810	41						
84 - 85							434	31	807	28	1241	58						
85 - 86	40	31					1115	111	353	60	1468	171	1022	72				
86 - 87		2					452	40	616	27	1068	67		22				
87 - 88							255	29	813	41	1067	70						
88 - 89		4	44	2		6	399	22	553	21	952	43		15	363	11		26
89 - 90	52	7					346	44	267	9	613	53	179	21				
90 - 91			19	1					213	19					189	9		
91 - 92	82	178	27	1	109	178	413	54	158	3	571	57	144	37	115	2	260	39
92 - 93	69	110	43	1	112	112	337	205	383	5	720	211	252	17	141	2	392	19
93 - 94	70	9	45	1	115	10	254	24	231	4	485	29	85	21	90	5	174	26
94 - 95	82	37	58	1	140	38	563	98	287	6	850	104	148	6	141	2	289	8
95 - 96	94	15	26	1	120	16	331	36	199	3	530	39	140	8	152	3	292	11
96 - 97	55	21	40	0	95	21	259	69	166	4	424	73	262	12	168	4	430	16
97 - 98	91	89	190	2	281	91	242	300	390	9	632	309	161	23	262	4	423	26
98 - 99	69	5	95	1	164	6	162	9	193	4	355	13	141	20	214	3	356	23

Key:

(grey cell) Nutrient Data not Available

Table 15
Comparison of 1998-99 Estimate Urban Runoff Total Nitrogen Loads with the Regional Board Phased TMDLs (in pounds)

	San Diego Creek @ Culver (Station 11)			San Diego Creek @ Campus (Station 10)			Peters Canyon Channel @ Barranca (Station 8)		
	Wet Season	Dry Season	Annual	Wet Season	Dry Season	Annual	Wet Season	Dry Season	Annual
1998-99 Total Nitrogen All Sources	69,000	95,000	164,000	162,000	193,000	355,000	141,000	214,000	356,000
Total Nitrogen from Urban Runoff (2002 proration)*	-	9,500	-	-	19,300	-	-	21,400	-
2002 TMDL Objectives for Urban Runoff	-	20,785	-	-	20,785	-	-	20,785	-
% Below (-) or Above (+) 2002 TMDL Objectives		-54	-	-	-7	-	-	+3	
Total Nitrogen for Urban Runoff (2007 proration)*	-	10,450	-	-	21,230	-	-	23,540	-
2007 TMDL Objectives for Urban Runoff	-	16,628	-	-	16,628	-	-	16,628	-
% Below (-) or Above (+) 2007 TMDL Objectives	-	-37	-	-	+28	-	-	+42	-
Total Nitrogen from Urban	26,220	10,450	39,360	61,560	21,230	85,200	53,580	23,540	85,440

Runoff (2012 proration)*									
2012 TMDL Objectives for Urban Runoff	55,442	16,628	72,070	55,442	16,628	72,070	55,442	16,628	72,070
% Below (-) or Above (+) 2012 TMDL objectives	-53	-37	-45	+11	+28	+18	-3	+42	+19

* Values estimated using percent of urban runoff TMDL to total TMDL from all sources, as presented in Table 1. Future focused studies will refine these estimates.

6. Recommended BMP Programs

This section of the report includes a general investigation and discussion of appropriate nutrient control BMPs, which may be applicable to the urban environment within the San Diego Creek Watershed. An estimate of current urban runoff nutrient loads within the watershed and comparisons with the TMDL limits were presented in Section 5. The following presents a very brief overview of the results presented in Section 5 followed by a general discussion of suggestions for future efforts and recommended BMPs.

The current (1998-99) estimated urban runoff nutrient loads at the three selected monitoring stations are below the year 2002 TMDL limits established for the Newport Bay Watershed/San Diego Creek (Reach 1), except for the dry season nitrogen load in Peters Canyon Channel at Barranca (Station 8) which is slightly (less than 3 percent) above the TMDL limit (see Section 5). In the year 2007, the current urban runoff nitrogen loads would be below objectives except for dry season total nitrogen loads at San Diego Creek at Campus (Station 10) and Peters Canyon Channel at Barranca (Station 8). By 2012, the current estimated nitrogen loads at San Diego Creek at Culver (Station 11) would be below the TMDL objectives. However, all computed loads in San Diego Creek at Campus (Station 10) and the dry season, and annual loads in Peters Canyon Channel at Barranca (Station 8) would be above the 2012 limits. Also, the computed 1998-99 phosphorous loads are all below the phased TMDL limits.

As mentioned in Section 5, the urban nutrient loads presented in this report were estimated due to lack of urban runoff nutrient data in this watershed. Thus, the main recommendation presented in this section is to supplement future monitoring efforts with specific source monitoring studies to better quantify nutrient loads from various sources including urban runoff. Special studies are recommended to be designed and implemented to identify and compare nutrient loads from urban runoff and other sources within the watershed (see Section 6.2.1). With more precise determination of urban runoff nutrient loads, a better evaluation of the TMDL criteria could be made. At that time, a detail of specific BMPs targeted to achieve the phased TMDL limits and a plan for their implementation could be presented. In addition, it is recommended that pilot studies be conducted to test effectiveness of special BMPs in reducing nutrient loads from urban sources (see Section 6.2.2). Upon completion of these focused studies, if it is found that special BMPs are in fact needed for compliance with TMDLs and the results of the pilot studies indicate that these BMPs are effective in achieving the targeted golas, the proposed BMPs shall be implemented throughout the watershed. At that time, the County in conjunction with the watershed cities shall evaluate these BMPs and provide a plan and schedule for their implementation. Examples may include making recommendations for special BMPs implemented as part of new development and/or redevelopment projects, new BMPs which may be incorporated by cities in addition to their current programs (see Section 4), and possible retrofit opportunities within the watershed which may be available as part of cooperative projects with entities such as the U.S. Army Corps of Engineers.

Since the current estimated loads are all below or very near the 2002 TMDL objectives, it can be assumed that the existing controls and BMPs are beginning to be effective in controlling nutrient loads in the watershed. For this reason, the main BMPs recommended in this report include continuations of the successful programs in place in the watershed. Many of the existing BMPs are non-structural measures that have been implemented in the past 5-10 years (See Section 4). With non-structural controls it typically takes over 5-10 years to observe any improvements. It is anticipated that with further implementation of the existing controls, additional nutrient reduction will be achieved. It is reasonable to assume that, with minor program revisions, complete compliance will be achieved by years 2007 and 2012.

A detailed review of relevant BMPs used nationwide was provided in the Newport Bay Urban Nutrient TMDL Technical report (7). The evaluation included both structural and non-structural BMPs. Information such as BMP description, limitations, benefits, pollutant removal efficiency (based on actual monitoring data), capital costs, and O&M costs were presented. The detailed information provided was intended to familiarize the reader with current nationwide practices as well as pilot studies being conducted in evaluating Best Management Practices (BMPs). This level of assessment was necessary before recommendation for future improvements could be made.

The work under this task includes a further evaluation of the BMPs with respect to the objectives of the TMDL compliance program and making recommendation for applicable BMPs. The criteria used in selection of the BMPs recommended in this section included: TMDL and percent load reduction objectives, nutrient attenuation and lifecycle costs, as well as area requirements for instituting new BMPs. As part of future focused studies two structural BMPs are recommended for further investigation. In addition, pilot studies are proposed to investigate urban nutrient load contributions. The investigation provided here includes general recommendations for the future BMP programs as well as an implementation workplan and schedule. A brief discussion from similar and applicable municipal programs is also included.

6.1 Effective Nutrient Control BMPs

This section provides a general overview of effective nutrient control BMPs, which may prove to be effective in ensuring compliance with the nutrient TMDL objectives in the Newport Bay/San Diego Creek Watershed. The recommendations are organized under two levels. The first level provides recommendations for continuation of and making minor revisions to the existing BMP programs already implemented. The second level includes recommendations for new BMP programs, which if implemented in addition to the first group of BMPs, may aid in meeting the nutrient control objectives of this program more rapidly.

6.1.1 Level One Recommendations

This first group includes recommendations for continuation of the effective stormwater control programs already established and implemented. The existing control measures were discussed in Section 4. Many of these programs have proved to be effective in reducing nutrient loads in the Newport Bay/San Diego Creek Watershed as well as similar locations in the nation. The general decreasing nutrient trends observed in the watershed (Section 5.3) may be indicative of the success of the existing BMP programs. Extensive resources have already been spent on development of these successful programs. The following is a list of suggestions that may be further evaluated and incorporated:

a. Documentation of all ongoing BMP activities. This shall include documentation and record keeping of all field logs and implemented Water Quality Management Plans (WQMPs) for new development and re-development projects as well as creation of summary activity sheets available for review. This information could be summarized and made available to all copermittees on a web page.
b. Development of standard maintenance procedures and field logs to ensure BMPs are properly maintained and BMP effectiveness is enhanced.
c. Use of uniform methods and equipment throughout the Watershed.
d. Further employee and contractor training.
e. Documentation of all maintenance activities.
f. Continuation and enhancement of existing public education programs to include nutrient control.
g. Implementation of the Regional Monitoring Program (RMP). This includes detailed monitoring activities to assess nutrient sources and dynamics. The RMP is composed of routine and special monitoring activities. Routine monitoring stations (including the San Diego Creek and Peters Canyon monitoring stations) were selected based on: (1) historical location of monitoring stations maintained by the County of Orange, (2) analysis of the current NPDES monitoring program and the proposed revisions to such program, (3) data used to develop the nutrient TMDL, and (4) areas of information that were missing in the development of the TMDL. Nutrient sampling at these stations is extensive (weekly and bi-monthly). Special monitoring includes further intensive studies within the watershed that would provide information to update and revise the nutrient TMDL, if necessary. These studies range from short duration, focused investigations into the nutrient loading from open space in the watershed to longer, more complex investigations, such as nutrient concentrations in bay and creek sediments and shallow groundwater loading to the creek system. The Peters Canyon Channel/San Diego Creek Nutrient Study (3) and Costa Mesa Channel focused study (discussed in Section 6.2.1.) are examples of these investigations. Future nutrient sampling efforts shall have a special focus on low flow monitoring. Testing at upstream and downstream locations of BMPs will aid in evaluating BMP effectiveness.
h. Review and incorporation of all information and nutrient data collected as part of compliance with the Regional Board Waste Discharge requirements (WDR) for nursery operations and agricultural activities into the program.

i. Implementation of San Diego Creek Watershed Enhancement Plan (See Section 4).
j. Review and incorporation of all related studies by others such as the proposed Regional Board investigations into the unknown sources of nutrients in the Newport Bay watershed.
k. Coordination with other water conservation and treatment activities, which may have a direct and/or indirect impact on the nutrient loads in the watershed.
l. Development of standard contract agreements for uniform cleanup and maintenance work throughout the watershed.
m. Development of watershed management/BMP implementation priorities.
n. Non-structural changes and scheduling changes for cleanup activities such as street sweeping and catch basin cleaning (prioritized to clean areas of heaviest pollutant loading).
o. Inclusion of a benefit-cost analysis to evaluate program effectiveness.
p. Review and revision of the program on an annual basis.

6.1.2 Level Two Recommendations

The second group of recommendations, focuses on additional BMPs, which if implemented properly will be further effective in removal of nutrient loads and may aid in meeting the nutrient control objectives of this program more rapidly. However, these BMPs generally require substantial resources and commitments. The following is an outline of these recommendations:

a. Collaborate with other counties and the State in development of a new State of California Best Management Practices Handbook. This handbook which could be used throughout the watershed may include details of routine and special BMPs. Structural and non-structural measures would be addressed. Examples of structural measures, which target control of nutrient runoff may include infiltration basins/ponds, use of natural drainageways, porous and concrete grid pavements, grass and bio-swales, french drains, berms, and drain inlet devices as well as increasing the percentage of permeable surfaces. The use of porous materials for or near walkways, driveways, parking lots and other paved surfaces will increase the amount of runoff that seeps into the ground, rather than being carried into storm drains. Other common practices, which will reduce urban runoff and thereby may help reduce nutrient loads, include diverting and reusing stormwater from areas where it can't seep into the ground. The use of sediment traps to intercept runoff from drainage areas and holding or slowly releasing flows so the sediments caught in the trap can be removed, may also prove to be effective.
b. Implementation of regional water quality control BMPs such as new constructed wetlands, rehabilitation programs, extended detention basins, and water quality basins. These BMPs may be incorporated as part of watershed planning efforts.

c. Establishment of a landscape irrigation and runoff control plan for uniform use throughout the Watershed.
d. Implementation of a more focused fertilizer management program with strict provisions for fertilizer application throughout the watershed.
e. Establishment of requirements for monitoring of runoff generated from major development and industrial activities.
f. In order to reduce nutrient load contribution from vegetated buffers surrounding parking lots, runoff generated from them should be controlled. Options may include using green strip filters and porous pavement to capture and percolate runoff where possible. Parking lot pollution can also be reduced by diverting runoff to permeable areas and by paving the lot with permeable materials or in permeable configurations.

6.2 Recommended Pilot Studies

This section provides a brief overview of the types of pilot studies that may be initiated to better understand stormwater nutrient load contributions from urban sources and their behavior/dynamics in the San Diego Creek/Newport Bay Watershed. To gain further knowledge of BMP effectiveness in control of nutrient loads, two promising structural BMPs, are recommended for further investigation. Finally, supplemental micro-level watershed studies could be conducted in order to characterize specific and major sources of loads within targeted watershed studies. The following is a brief description of these pilot studies.

6.2.1 Future Potential Sites for Conducting Nutrient Load Source Identification

To evaluate compliance with the urban nutrient load allocation and to evaluate effectiveness of control actions, it is necessary to develop an assessment approach that can address the diversity of potential nutrient sources within an urban environment. This involves characterizing nutrient loading from different land-use patterns and generating information that can be applied across the watershed based on what is determined at specific locations. In the year 1999, a similar effort was initiated by PFRD on a typical urban area within the Costa Mesa Channel watershed. This watershed covers 972 acres. The land-uses represented in the Costa Mesa Channel watershed investigation are:

· Commercial	95 acres
· Low density Residential	701 acres
· Medium-High Density Residential	98 acres
· Open space/Recreational	29 acres
· Public/Institutional	2 acres
· Vacant	44 acres
· Waterway/Floodway	3 acres

A preliminary analysis of nutrient loads from the Costa Mesa Channel Watershed was made for the 1998-99 Dry season and 1999-00 wet season. The preliminary results indicated a total nitrogen and total phosphorous load of 1,100 pounds and 400 pounds for the dry season, and a total nitrogen and total phosphorous load of 3,200 pounds and 800 pounds for the wet season, respectively. For this period, the nitrate concentrations at the Costa Mesa Channel Watershed were much lower than the nitrate concentration at the three selected monitoring stations. Table 16 provides a summary of the nutrient loads for the Costa Mesa Channel Watershed.

It should be noted that the loads presented on Table 16 were computed using data from one season only. However, the nutrient monitoring effort in the Costa Mesa Channel is going to be continued in the future years. With further nutrient data, the loads presented above may be better refined.

A key characteristic of this site is that it generates nutrients that can be attributed to urban runoff, not other sources. Specifically, surface water from this site does not receive water from groundwater sources. Hence, nutrient loading from this area can be defined from stormwater sources including atmospheric deposition. Atmospheric deposition will be measured by establishing a bulk and wet precipitation sampling station. This will allow for the accounting of dry and wet nutrient deposition. Uncontrollable atmospheric nutrient loading will be calculated using these data. The nutrient loading from stormwater runoff can then be adjusted to represent land-use sources for the watershed. The nutrient loading data may be applied to other areas within the watershed to define the surface water nutrient loading generated from urban sources.

In addition to the Costa Mesa Channel Study, two representative sampling stations with similar tributary areas, but different land use covers (one with uniform urban land use and the other with mixed land use), are proposed to be implemented to evaluate and compare nutrient load contributions. The tributary watersheds to these sampling stations should be relatively small. Nutrient loading data for the standard watersheds may be used in the evaluation of nitrogen and phosphorus load allocations for urban runoff. Nutrient loading rates for the land-uses may be determined by monitoring runoff during storm and non-storm events. The goal will be to define nutrient loads generated from low flow samples as well as from different storm events. Additionally, this investigation will provide an insight into the relationship between nitrogen and phosphorus generation and sediment loading. This information may be used to identify, select, and implement appropriate controls and best management practices. Upon implementation of control technologies and activities, nutrient-loading rates can be re-calibrated to reflect the real impact of BMPs. This data will represent real-time reflections of current management practices.

In addition, Irvine Ranch Water District is currently conducting an evapotranspiration controller study, which focuses on landscaped areas. This investigation includes an analysis of BMPs for efficient control of landscaped irrigation. Preliminary results from this study indicate that water conservation efforts have proven to be very effective in reduction of nutrient loads. Future work shall include an evaluation of information from this investigation for comparison with results of the proposed pilot studies.

Table 16
Summary of Nutrient Loads for Costa Mesa Channel Watershed

98-99 DRY SEASON												
	Volume	Expected Value (mg/L)				Loads (1000 lbs)						
	(L*10^3)	NO3	NH3 as N	TKN	PO4	NO3	NO3 as N	NH3 as N	TKN	TN	PO4	PO4 as P
Expected Value	213,112	1.8	0.9	1.9	2.5	0.9	0.2	0.4	0.9	**1.1**	1.2	**0.4**
90% Low Confidence	213,112	0.3	0.1	0.4	1.5	0.1	0.0	0.0	0.2	**0.2**	0.7	**0.2**
90% High Confidence	213,112	4.1	2.0	3.9	3.7	1.9	0.4	0.9	1.8	**2.3**	1.7	**0.6**
99-2000 WET SEASON												
	Volume	Expected Value (mg/L)				Loads (1000 lbs)						
	(L*10^3)	NO3	NH3	TKN	PO4	NO3	NO3 as N	NH3 as N	TKN	TN	PO4	PO4 as P
Expected Value	581,788	3.2	0.4	1.8	2.0	4.2	0.9	0.5	2.3	**3.2**	2.5	**0.8**
90% Low Confidence	581,788	0.7	0.1	0.7	1.1	0.9	0.2	0.1	0.9	**1.1**	1.4	**0.4**
90% High Confidence	581,788	6.9	1.0	3.2	3.1	8.8	2.0	1.2	4.1	**6.0**	3.9	**1.3**
Notes:	No data points were excluded for storm flows in this analysis											
	Flow volumes are estimated based on rainfall data from Costa Mesa precipitation gage (#219)											

6.2.2 Structural BMP Testing

Pilot studies may be performed to evaluate nutrient loads associated with urban runoff and to assess various BMPs currently implemented in the watershed. Los Angeles County is currently conducting a Critical Source/BMP study. The investigations in the Newport Bay/San Diego Creek Watershed should follow, as closely as possible, the same protocols that LA County has established. The following are the BMPs that the copermittees currently plan to examine:

- Motor fuel concrete dispensing area interruptible drainages
- Trash container/dumpster areas
- Street sweeping efficiencies
- Inlet trash racks

In addition to the above studies, two existing and promising structural BMPs within the watershed may be tested in order to comprehend the potential nutrient removal capabilities that may be available and may aid in achieving the TMDL goals. The two BMPs proposed for this focused study include: 1) an extended detention basin, and 2) a grass (natural) swale system. These BMPs should be located at the downstream outfall of mostly urban tributary areas. Sampling shall include continuous composite effluent and influent sampling of at least five representative storms in the wet seasons of the years 2001-2002 through 2003-2004. Samples should be tested for nutrient compounds as well as other indicators such as dissolved oxygen and temperature. Stormwater samples shall be supplemented with complete flow data.

The BMP study should include selection of appropriate monitoring designs/protocols, as well as implementation, and monitoring activities upstream and downstream of the BMPs to evaluate their efficiencies for nutrient removal within the Newport Bay watershed. The selected structural BMPs will be evaluated by testing influent and effluent composite samples during representative storm events. Finally, event mean concentrations will be converted into loads and statistical procedure will be applied to compute expected nutrient loads, confidence limits, and removal efficiencies.

6.2.3 Micro-Level Source Identification Proposal

The purpose of the micro-level source identification study is to characterize specific and major sources of nutrient loads within the urban areas of the watershed. This analysis will provide insight into pollutant loads from specific urban uses/sources. Land uses and sources with the highest suspected contribution to nutrient pollutant loads such as landscaped and fertilized areas should be the main focus of the micro-level investigation. This analysis may comprise of a simple comparison of homogenous subwatersheds with similar hydrologic regimes but differing land uses. For better control, small watersheds with one predominant land use may be selected. It is suggested that the subwatersheds under investigation should have similar sizes and shapes. It is also important that the subwatersheds under investigation should not have implemented any pollution prevention controls in order to characterize the true contributing loads with out the influence of any controls.

The micro-level source identification study proposed here includes a comparative study to investigate nutrient load contributions from a predominantly impervious cover with no landscaped area such as a parking lot or an industrial area to an area with mostly pervious and landscaped cover (preferably fertilized). For the purposes of comparison it is important that the two subwatersheds be similar and homogenous in all aspects except for the land use coverage.

This comparative study will include design and implementation of monitoring stations at the points of outfall from these subwatersheds. The monitoring stations will be comprised of automatic stormwater samplers equipped with rain and flow gauge monitors. The micro-level investigation will include site selection, design, hydrologic and hydraulic investigation and design (if needed), equipment installation, calibration and testing, monitoring, data collection and analysis. The micro-level evaluation is suggested to be initiated in the 2001-2002 period and to include low flow sampling as well as storm sampling in the wet and dry seasons. Sampling should include flow composite samples from at least five complete representative storms in the wet season and on a monthly basis (24-hour composites) throughout the year. Analysis should include conversion of data into pollutant loads and statistical testing to hypothesize the differences between the two monitoring stations with different land uses.

7. Implementation Plan and Schedule

Table 17 provides an outline of specific tasks and work schedule involved in meeting the nutrient target TMDLs. Upon completion of future studies recommended in Section 6 and a better definition of urban nutrient loads, the proposed plan and schedule may be further modified to better address the TMDL objectives.

Table 17
Nutrient TMDL Compliance-
Newport Bay/San Diego Creek Watershed Workplan Schedule

Table 17
Nutrient TMDL Compliance - Newport Bay/San Diego Creek Watershed
Workplan Schedule

From / To			10/1/00	7/1/01	7/1/02	7/1/03	7/1/04	7/1/05	7/1/06	7/1/07	7/1/08	7/1/09	7/1/10	7/1/11
	7/31/00	9/30/00	6/30/01	6/30/02	6/30/03	6/30/04	6/30/05	6/30/06	6/30/07	6/30/08	6/30/09	6/30/10	6/30/11	6/30/12
Workplan Tasks														
1. Submit Nutrient TMDL Technical Report to the Regional Board														
2. Reginal Board Approval of Technical Report and Workplan														
3. Implement Regional Monitoring Program														
4. Prepare NPDES Annual Progress Report Including Nutrient Load Calculations														
5. Compare Nutrient Loads with TMDL Objectives to Assure Compliance														
6. Document BMP/Maintenance activities														
7. Develop Standard BMP Procedures and Field Logs														
8. Establish Monitoring Requirements for Development Projects and Industrial Dischargers														
9. Develop Standard Contract Agreements														
10. Provide Benefit-Cost Analysis for Evaluating Existing BMP Programs														
11. Provide Pilot Study Outline for Testing Two Existing Strucutral BMPs														
12. Develop Specific Design and Monitoring Plans for Testing Influent and Effluent Samples from the Two Strucural BMPs using Automated Samplers														
13. Flow-weighted Composite Sampling from 5 Storms at Two Existing Strucural BMPs														
14. Summarize Results of BMP Testing Including Loading and Efficiencies														
15. Provide Pilot Study Outline for Conducting Nutrient Source Identification														
16. Develop Specific Design and Monitoring Plans for Conducting Nutrient Source Load Pilot Studies														
17. Pilot Study Including Low Flow and Stormflow Sampling from 5 Individual Events														
18. Sumamrize Results of Source Identification Monitoring Study Including Computed Loads														
19. Summarize Results from Costa Mesa Channel Study Including Computed Loads														
20. Provide Micro-level Source Identification Study Outline														
21. Develop Specific Design & Monitoring Plans for Conducting Micro-level Source Study														
22. Micro-level Source ID Study														

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